VOL. XIX, PART IV Published 12 June 1935

# The British Mycological Society

*(Recognosce notum, ignotum inspice)*

# TRANSACTIONS

Edited by

J. RAMSBOTTOM, B. F. BARNES and H. WORMALD

*Price to non-members, Seven Shillings & Sixpence*

LONDON
CAMBRIDGE UNIVERSITY PRESS
FETTER LANE, E.C. 4
CHICAGO: THE UNIVERSITY OF CHICAGO PRESS
(AGENTS FOR THE UNITED STATES)
BOMBAY, CALCUTTA, MADRAS: MACMILLAN
TOKYO: MARUZEN COMPANY LTD.

*All rights reserved*

PRINTED IN GREAT BRITAIN

# LIST OF OFFICERS AND COUNCIL FOR 1934

*Elected September* 1933

*President*

Dr B. Barnes, D.Sc., Ph.D., F.L.S.

*Vice-Presidents*

Carleton Rea, B.C.L., M.A.

Professor W. Brown, M.A., D.Sc.

*General Secretary*

J. Ramsbottom, O.B.E., M.A., Sec.L.S.

British Museum (Nat. Hist.), Cromwell Road, London, S.W. 7.

*Secretary*

Miss E. M. Wakefield, M.A., F.L.S.

The Herbarium, Royal Botanic Gardens, Kew, Surrey.

*Treasurer*

A. A. Pearson, F.L.S.

59, Southwark Street, London, S.E. 1.

*Editors*

J. Ramsbottom, Dr B. Barnes

and

Dr H. Wormald.

## COUNCIL

The Officers, with the following in addition:

A. W. Bartlett, F. T. Brooks, Prof. A. H. R. Buller, Dr E. J. Butler, E. N. Carrothers, K. St. G. Cartwright, A. D. Cotton, Prof. O. V. Darbishire, F. G. Gould, Dame H. C. I. Gwynne-Vaughan, J. S. Hughes, Dr G. H. Pethybridge, Prof. M. C. Potter, Prof. E. S. Salmon, Dr Alex. Smith, E. W. Swanton, W. H. Wilkins.

## COMMITTEE FOR PLANT PATHOLOGY

A. Beaumont
Dr W. B. Brierley
Prof. W. Brown
W. Buddin
Dr W. J. Dowson
R. W. Marsh
W. C. Moore (*Secretary*)
A. E. Muskett
Dr G. H. Pethybridge (*Chairman*)
W. M. Ware
S. P. Wiltshire
Dr H. Wormald

The President and Secretaries of the Society *ex officio*

# STUDIES ON BRITISH PYRENOMYCETES

## I. THE LIFE HISTORIES OF THREE SPECIES OF *CEPHALOTHECA* FUCK.

By CHAS. G. C. CHESTERS

(With Plates XI and XII and 5 Text-figures)

### I. Introduction

It is proposed to publish the results of a series of investigations by pure culture methods of the life histories of selected species of Pyrenomycetes, paying particular attention to the development of the imperfect stages and to the development and cultural requirements of the ascophorous stages where these are obtained. Pyrenomycetes are known mainly in their perfect stage, and precise information of the imperfect condition is often lacking. Generic and specific diagnoses which may later be used in an attempt to indicate the evolution of the group as a whole should be on a wide comparative basis. The immediate necessity appears to be to provide detailed accounts of the development of the spore-bearing structures of definite species.

Winter (10), following Fuckel, retained the genus *Cephalotheca* in his suborder Perisporieae of the Pyrenomycetes, but Fischer (3) placed it in the Aspergillaceae which he treated as a family of his new order, Plectascineae, definitely removed from the Pyrenomycetes. Von Höhnel (5) suggested that the genus should be transferred to a separate family, Cephalothecaceae, which, though related to Aspergillaceae, contained types with a specialised perithecial structure for the liberation of the ascospores. In this he was followed by Nannfeldt (7). It is not intended to consider here the validity of Pyrenomycetes as a specialised class within the Ascomycetes; in this series of papers the word is used in the sense employed by Winter.

In order that the systematic position adopted may be clear, a summary is given below, and the reasons which led to this will be discussed in later sections.

***Cephalotheca*** Fuck. *Symb. Myc. Nachtr.* I (1871), 9 (297).

Syn. *Crepinula* O. Kuntze, *Rev. Gén.* Pl. II (1891), 850.
*Fairmania* Sacc. in *Ann. Mycol.*, IV (1906), 276.
*Aposphaeriopsis* Died. *pro parte* in *Ann. Mycol.* XI (1913), 44.
*Fragosphaeria* Shear in *Mycologia*, XV (1923), 124.

(1) *C. sulfurea* Fuck. Type species, *loc. cit.*
(2) *C. reniformis* Sacc. & Therry apud Sacc. in *Mich.* II (1881), 312.
Syn. *Fairmania singularis* Sacc. *loc. cit.*
*Aposphaeriopsis fusco-atra* Died. *loc. cit.*
(3) *C. purpurea* (Shear) comb.nov.
Syn. *Fragosphaeria purpurea* Shear, *loc. cit.*

## II. Comparison of material collected with authentic material and original descriptions

Each field collection of the species investigated from which monospore cultures were obtained was compared either with authentic material or, failing this, with the original diagnosis. All the material which I have examined or which has been examined on my behalf is given below.

(1) *C. sulfurea* Fuck.

*Authentic material.* Fuckel, Fungi Rhenani, 2313, preserved in the Herbaria of: (1) The British Museum, general fungus collection. (2) C. E. Broome; incorporated in the British Collection in the British Museum. (3) The Pathological Collection, Bureau of Plant Industry, Washington, U.S.A.* (4) The Royal Botanic Garden, Kew.† (5) The Botanischer Garten und Museum, Berlin Dahlem (specimen kindly loaned by Prof. Dr E. Ulbrich).†

*British Material.* C. E. Broome's material was collected at: (*a*) Bristol, April 1876, and (*b*) Henbury, October 1879.

*Material used for isolation.* Collected by W. B. Grove, on garden cane, Birmingham, 1931. Preserved in my herbarium, No. 4.

(2) *C. reniformis* Sacc. & Therry.

No authentic or other material available for comparison. (The type specimen is cited by G. Gola (1930) in *L'erbario Micologico di P. A. Saccardo*, p. 165, as being preserved in Saccardo's herbarium.)

Material used for isolation was collected on dead beech, Richmond Park, Surrey, September 1931 (No. 1167) and June 1932 (No. 1223) by Mr E. W. Mason, and on dead oak, Birmingham, June 1933 (No. 5) and February 1934 (No. 67) by myself.

(3) *C. purpurea* (Shear) comb.nov.

*Authentic material.* In Herbarium C. L. Shear: pure culture tube No. 4821, on corn-meal agar (cf. Shear *loc. cit.* p. 125).‡

Material used for isolation was collected by Mr E. W. Mason on

* C. L. Shear, *in litt.*
† Without any discernible fungus, E. W. Mason, *in litt.*
‡ I am indebted to Dr Shear not only for comparing with his type specimen isolations from collected material sent to him, but also for providing me with a slide from his specimen.

dead beech, Richmond Park, Surrey, July 1932 (No. 1228), and on dead oak, April 1933 (No. 12 of my herbarium).

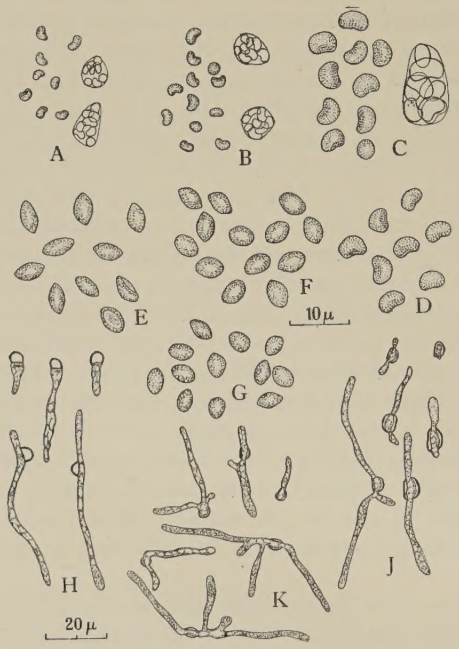
(1) *C. sulfurea* Fuck.

The genus was founded on *C. sulfurea* and *C. trabea*. The former was placed first, has been recognised since on more than one occasion, and is universally recognised as the type species.

The collection made by W. B. Grove consists of discrete groups of astomous perithecia of various ages surrounded by a sulphur-coloured villus of rather flexuose hyphae (Pl. XI, fig. 1). The young perithecia are totally embedded in the general mycelium and are individually covered by sulphureous hyphae (Pl. XI, fig. 1 A). The mature perithecia (250–500$\mu$ in diameter) are glabrous at the apex, black, and have a series of definite suture lines regularly disposed over their surface (Pl. XI, fig. 1 B). The polygonal areas delimited by these sutures are often torn apart, revealing a mass of brown ascospores (Pl. XI, fig. 1 C). The oldest perithecia are completely shattered and only a basal cup remains in which the ascospores are loosely held together in small clusters (Pl. XI, fig. 1 D). The perithecia, though embedded in mycelium, are not immersed in the substance of the cane. The ascospores, which are elliptical to ovate (Text-fig. 1 E) and individually of a light brown, measure 4·5–6 × 3–4$\mu$ (mostly 6 × 4$\mu$). Asci attached to ascogenous hyphae were not observed in this material, but Fuckel (*loc. cit.*) describes the asci as forming globose clusters at the ends of branched hyphae. Von Höhnel(5) stated that the perithecia of this species, in addition to being fragile, break up along definite suture lines such as those which have been described above.

The two specimens of Fungi Rhenani, No. 2313, in the Herbarium of the British Museum, bear numerous groups of young and adult perithecia enclosed within a definitely sulphureous villus. The mature, but unshattered, perithecia are from 330 to 500$\mu$ in diameter, and in both specimens perithecia having sutures can be observed. The ascospores are elliptical or ovoid (Text-fig. 1 F) and measure 4–6 × 3–4$\mu$. The characteristic size appears to be 6 × 4$\mu$, and no ascospores longer than 6$\mu$ have been observed. Hence Fuckel's original measurement of 6–7 × 3$\mu$ is in need of some slight emendment. The specimen in the Pathological Collection of the Bureau of Plant Industry, Washington, was examined by Dr C. L. Shear who states (*in litt.*) that: "The perithecia are covered with a sulphur-colored layer of hyphae which seems to bear small hyaline globular conidia. Whether this is really genetically related to the perithecia or not is a question.... The perithecia when free break up in much the same manner as in *Fragosphaeria*, and the wall is of the same characteristic structure, and the spores brown. Fuckel's specimen is labelled on Oak."

The British material of *C. sulfurea* in the Broome Herbarium in the British Museum consists of two separate collections, that of October 1879 having young perithecia, some of which show suturing of the wall and all of which are embedded in the characteristic sulphur-coloured mycelium; and that of April 1876 having fully mature and often shattered perithecia with ascospores which measure from 4 to 5·5 × 2·5 to 3μ (Text-fig. 1 G). The latter material is that from which




Text-fig. 1. Ascospores of species of *Cephalotheca*. A, *C. purpurea* (Shear's culture tube No. 4821). B, *C. purpurea* (Mason, No. 1228). C, *C. reniformis* (Mason, No. 1223). D, *C. reniformis* (Mason, No. 1167). E, *C. sulfurea* (Chesters, No. 4). F, *C. sulfurea* (Fung. Rhen. No. 2313). G, *C. sulfurea* (Berkeley & Broome, No. 1729). H–K, germinating ascospores (H, *C. sulfurea*; J, *C. reniformis*; K, *C. purpurea*).

the illustrations published in the *Annals and Magazine of Natural History* (Pl. XII, fig. 1) of 1878 were drawn ((1), p. 30). Berkeley and Broome observed the asci of this species but referred to them (*loc. cit.* p. 30) as "Sporangia"; in this they were followed by Cooke (*Grev.* VI (1878), 128).

The reference which Shear makes to "small hyaline globular conidia" associated with the sulphur-coloured mycelium about the perithecium is of interest. Similar conidia are present in the specimen of Fungi Rhenani, No. 2313, in the British Museum. They measure 3–4 × 3μ and occur in chains of two to several spores, but they have

not been observed attached to mycelium. They are present in considerable numbers in the British collection of Broome of 1879 which contains only immature perithecia. They are not present on the collection of W. B. Grove, but, as will be described later, they are formed on the mycelium produced from the germinated ascospores of this collection.

The collection of *C. sulfurea* from which monospore cultures were obtained agrees precisely as regards the mycelium, perithecia and ascospores with the authentic material of the species and with the previous British collections. Further, conidia present upon authentic material and also on one previous British collection correspond exactly with those produced in culture.

(2) *C. reniformis* Sacc. & Therry

No authentic material of this species was available for examination and comparison, but all the collections of the fungus which have been made agree with the authors' description (*loc. cit.* p. 312), which may be translated thus:

"Perithecia gregarious, nestling among the cortical fibres or at length superficial, globose, mouthless but sometimes with a small apical papilla, later frequently collapsing and becoming cupulate, fuscous black in colour, $\frac{1}{3}$–$\frac{1}{4}$ mm. in diameter; at first clothed all over with filiform fuliginous hairs $2\mu$ in diameter, afterwards becoming glabrous except at the base, with a somewhat thick, fuscous, small celled, parenchymatous texture; asci either globose, $10\mu$ in diameter, or ellipsoid $15 \times 14$–$12\mu$, evanescent, eight-spored, ascospores conglobate, reniform, $4$–$5 \times 3$–$3{\cdot}5\mu$, at first olivaceous, later becoming slightly fuliginous.

"Growing in the decorticated branches of decayed Poplar, Lyon, May 1880. Easily distinguished from other species by the small reniform ascospores."

The several collections of this species which I have examined and from which monospore cultures have been obtained all exhibit small perithecia scattered throughout the decayed wood. On beech wood they are mainly clustered round the cavities left by the destruction of medullary ray tissue (Pl. XI, fig. 2), while on oak they are either dispersed throughout the wood or occur in dense masses in, and along, the walls of channels made by a boring beetle. Uncovered by any mycelial investment, the mature perithecia appear as black, shining spherical structures (Pl. XI, fig. 6), 250–350$\mu$ in diameter, showing no obvious suturing of the carbonaceous wall. When shattered, the lower part of the wall usually remains intact as a cup within which lies the rather brown powdery mass of spores (Pl. XI, fig. 3). If the perithecia are slowly dried, the splitting of the wall can be observed to take place indiscriminately so that irregularly shaped areas from

the distal portion of the perithecium are set free. The ascospores (Text-fig. 1 C and D), which are held together in clusters, are definitely reniform, light brown and 4·5–5·0 × 3·0–3·8μ. The perithecia, unlike those of *C. sulfurea*, are attached to the substratum by a mass of dark brown hyphae radiating from the base of the fruit body and penetrating into the wood.

The finding of this species upon beech at Richmond constitutes the first record of the species in Britain. Since then it has been observed on several occasions at Richmond and Birmingham. In every case the wood has been attacked by a boring beetle, and it is quite possible that the fungus is spread by the beetle.

(3) *C. purpurea* (Shear) comb.nov.

The collection of this species on dead beech at Richmond in 1932 represents its discovery in Britain and also the first field collection on the host plant. The material upon which the original description is based (Shear, *loc. cit.*) was obtained in culture as a contaminant of plates poured for the isolation of *Pilacre Petersii* from beech wood. The Richmond material bears both superficial and immersed perithecia, the latter being situated along the air spaces produced by the decay of the medullary rays. The wood is generally stained brown or brownish purple in the vicinity of the perithecia. These are dark in colour, usually black, and when mature show marked suturing of the wall (Pl. XI, fig. 4). Upon dry wood the majority of the perithecia are shattered (Pl. XI, fig. 7) to such an extent that only a flattened plate of loosely connected polygons of wall tissue remains. This may have a few ascospore clusters scattered over its surface (Pl. XI, fig. 5). Although the base of the perithecium may be slightly embedded in a superficial mycelium or in the rotted wood, it is never definitely attached to the substratum as are the perithecia of *C. reniformis*. In this it resembles *C. sulfurea*. The collection on oak has younger perithecia, and these are separately covered by a weft of purple-coloured hyphae and the walls are also similarly tinted. The vestment of hyphae in this case is soft and not strictly comparable with the sulphureous villus of *C. sulfurea* where the individual hyphae are thickened and flexuose. The asci (*vide* Table I) are subglobose to globose (Text-fig. 1 B) and are arranged in clusters, and although they are evanescent the eight broadly bean-shaped ascospores (Text-fig. 1 B) remain grouped together even after the perithecial wall is shattered. The ascospores measure 2·5–3·0 × 1·5–2·0μ and are light brown in mass but individually more or less hyaline. By itself this species could legitimately be considered as perhaps belonging to the "Hyalosporeae" where in fact it is placed in Clements and Shear, *Genera of Fungi*.

Cultures of mature perithecia were sent to Dr Shear who was so good as to compare them with his type specimen (Pl. XII, fig. 2), and

also to send me a slide of perithecia and ascospores prepared from his type specimen (Pl. XII, fig. 3 and Text-fig. 1 A). He states that: "Your dried culture... I should say is undoubtedly our *F. purpurea*" (*in litt.*). As will be seen from Table I, there is no significant difference between the measurements of the American and British materials of this species. Referring to the generic status of *Cephalotheca sulfurea* and *Fragosphaeria purpurea* Dr Shear states (*in litt.*) that: "At present, I am inclined to think that so far as the genera are concerned they are the same...."

Table I. *Measurements of perithecia and spores of species of* Cephalotheca.

| Specimens examined | Perithecia | Asci |
|---|---|---|
| *C. sulfurea:* | | |
| (1) Exsicc. Fung. Rhen. No. 2313 | 330–500μ | 10μ diam. |
| (2) Exsicc. Berkeley and Broome No. 1729, in Herb. Brit. Mus. | — | — |
| (3) Exsicc. Chesters No. 4 | 250–500μ | 8–11μ diam. |
| *C. reniformis:* | | |
| (1) Measurements from *Syll.* 1, p. 37 | 250–330μ | 15×14–12 or 10μ diam. |
| (2) Exsicc. Mason No. 1167 | 250–350μ | 11×8–10 or 10–11μ diam. |
| *C. purpurea:* | | |
| (1) Measurements from Shear (*loc. cit.* p. 124) | — | 4–6μ diam. |
| (2) Exsicc. Mason No. 1228 | 300–350μ | 5·0–6·5μ diam. |

| Specimens examined | Ascospores | Conidia |
|---|---|---|
| *C. sulfurea:* | | |
| (1) Exsicc. Fung. Rhen. No. 2313 | 4–6×3–4μ | 3–4×3μ |
| (2) Exsicc. Berkeley and Broome No. 1729, in Herb. Brit. Mus. | 4–4·5×2·5–3μ | 3–4×2·0–2·5μ |
| (3) Exsicc. Chesters No. 4 | 4·5–6×3–4μ, mostly 6×4μ | 4·5–5×2–3μ (cultures) |
| *C. reniformis:* | | |
| (1) Measurements from *Syll.* 1, p. 37 | 4–5×3·0–3·5μ | — |
| (2) Exsicc. Mason No. 1167 | 4·5–5×3·0–3·8μ | 4–5×1·5–2μ (cultures) |
| *C. purpurea:* | | |
| (1) Measurements from Shear (*loc. cit.* p. 124) | 2·25–2·75×1·5–2μ | 3–4×1·0–1·5μ |
| (2) Exsicc. Mason No. 1228 | 2·5–3·0×1·5–2μ | 3–4×1·0–1·5μ |

The comparisons made in the foregoing pages appear to me to indicate that the species under investigation can be identified with previous descriptions and material of three species, two of which are already recognised as belonging to *Cephalotheca*. The life histories of the three species will indicate similarities which necessitate their common treatment in a single genus.

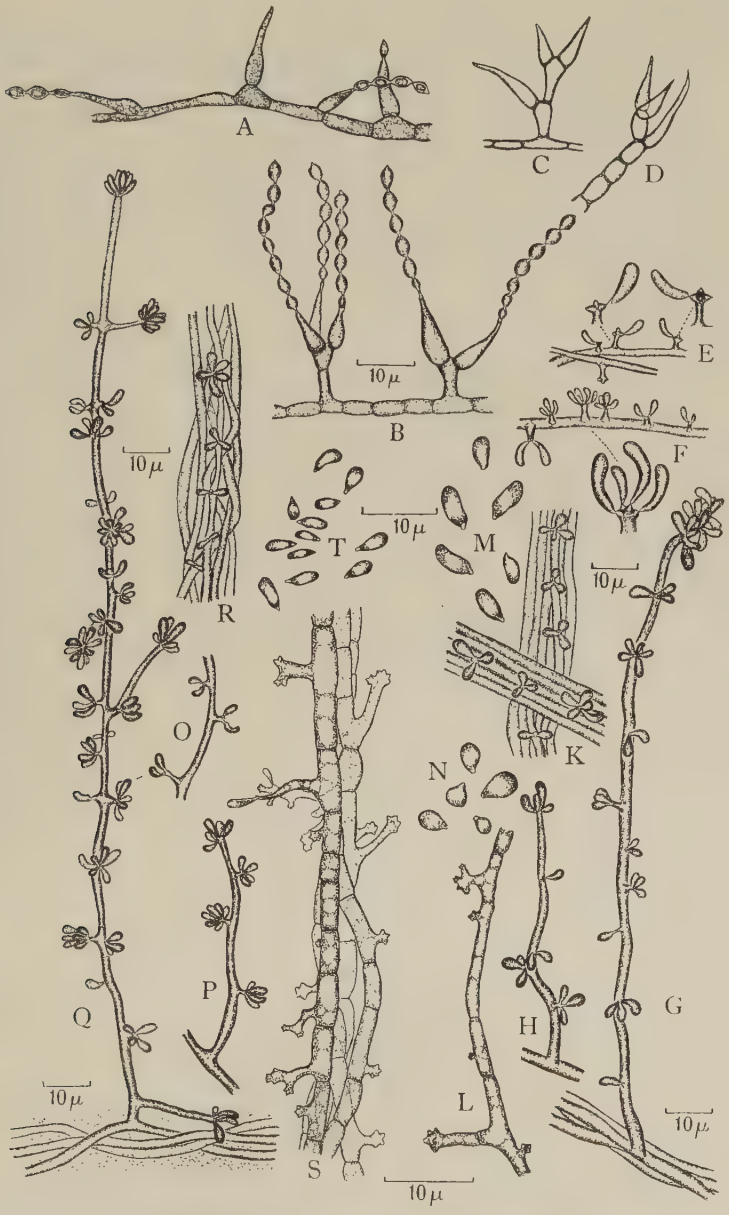
## III. The life histories

### (*a*) *The conidial stage*

The freshly discharged ascospores germinated easily on a variety of media, but the species show marked differences in the optimum temperature for germination. Those of *C. sulfurea* have an optimum temperature between 16 and 18° C., those of *C. reniformis* between 20 and 26° C., and those of *C. purpurea* between 22 and 26° C. In each case the germ tubes are produced from the poles of the spore (Text-fig. 1 H–K) and the first lateral branch is formed near to the ascospore. Conidia are developed within two to four days after germination. The conidial stage appears earliest in *C. purpurea* and latest in *C. sulfurea*. In each species the first conidia are borne upon conidiophores which are simpler than those present on mature mycelium.

(1) *C. sulfurea.*

The conidia are formed on simple, erect, unicellular branches which are at first of an even thickness throughout their length, but during growth the apical part becomes attenuated and the whole forms a simple flask-shaped cell (Text-fig. 2 A). The first spore is formed as a distal swelling which remains in open communication with the hypha until a second, and lower, spore is differentiated. The wall between the two spores now contracts so that the protoplasmic continuity is severed and a small bridge of wall material separates the two spores. This basipetal formation is repeated and a chain of spores of some considerable length is produced (Text-fig. 2 B). The flask-shaped conidiophore must be regarded as a phialide producing serial phialospores(6) which for a time remain in contact with one another. The conidia are liberated either in units or in small linear series; they never collapse into a sticky mass. The conidia are small, uninucleate, ovate structures (*vide* Table I) which germinate easily upon a variety of media or in tap water. Simple phialides occur on the young mycelium and on aerial parts of the old mycelium, but the surface plexus of hyphae produces more complex structures (Text-fig. 2 B) which may be immersed, and are reminiscent of a rather lax penicillioid growth. On these the phialides arise from branches which may be one or more cells in height (Text-fig. 2 B–D), with an apical group of two or more phialides and lateral phialides, either singly or in groups, throughout their length (Text-fig. 2 C). The very considerable, widespread spore production gives the adult mycelium a white or yellowish powdery appearance. The colour varies on different media and at different temperatures. It is most intense on oat agar containing sucrose at 18° C. No pigmentation of the medium occurs.




Text-fig. 2. A–D, phialides and phialospores of *C. sulfurea*. E–N, fertile hyphae and radulospores of *C. reniformis*. O–T, fertile hyphae and radulospores of *C. purpurea*. For further explanation see text.

(2) *C. reniformis.*

The conidia, which are falcate and 4–5 × 1·5–2$\mu$ in size (Text-fig. 2 M), are always borne upon minute papillate processes (Text-fig. 2 E). In their simplest form these arise singly on the cells of the superficial and aerial mycelium (Text-fig. 2 G and H); in their most complex form they are arranged in masses over the ends of swollen lateral projections (Text-fig. 2 F–L). A septum may very occasionally occur at the base of these projections, thus forming a simple unicellular conidiophore. In this latter case a definite spiral arrangement can be traced in the order of production of the papillae (Text-fig. 2 K and L). This type of spore formation was differentiated among others as a "radula* spore form" by Mason (6). In the present state of our knowledge it would be unwise to compare directly this spore form with the phialospores of *C. sulfurea*. A relevant case may be cited from *Botrytis cinerea*, where the "Botrytis" spore is a higher development of the radula spore type shown by *C. reniformis*, and phialospores comparable to the conidia of *C. sulfurea* are represented by the so-called microconidia. On most agar media the mycelium of *C. reniformis* consists of a matted surface growth of interwoven strands of hyphae producing abundant conidia which give the mycelium a somewhat waxy appearance and cream-like colour. As the medium dries out, or upon hard agar or wood, superficial rope-like strands develop which bear upright fertile hyphae of varying length (Text-fig. 2 G and H). This type is floccose in appearance.

(3) *C. purpurea.*

The conidial condition of this species was described by Shear (*loc. cit.* p. 124) as: "Thin, white, effuse, much branched; conidia formed on somewhat enlarged, elongated, and roughened ends of the alternately branched fertile hyphae (Pl. XII, fig. 4), oblong-elliptic, inequilateral or suballantoid, non-septate, hyaline, 3–4 × 1–1·5$\mu$." The fertile hyphae of isolations from British material only occasionally branch in a regularly alternate manner (Text-fig. 2 P). The branching of large fertile hyphae is very irregular (Text-fig 2 Q). The genesis of the individual conidium (Text-fig. 2 O–S) is precisely similar to that of *C. reniformis*, and though somewhat smaller (see Table I), it has the same shape (Text-fig. 2 T). The cultures are more flocculent than those of *C. reniformis*, due to the more extensive development of aerial mycelium. On microscopic characters alone it would be impossible to differentiate the conidial stage of *C. purpurea* from that of *C. reniformis*. The macroscopic appearance of the cultures is certainly different in a degree, but not to such an extent as would allow one without previous knowledge of the perithecia connected with each species to consider them specifically distinct.

* *radula* (Latin)=nutmeg grater.

(*b*) *The ascophorous stage*

Perithecia are only abundant when the factors which influence the growth of each species are at their optimum value. Of these factors the composition of the medium, the humidity of the atmosphere and the temperature are the most important, provided that the reaction of the medium falls within *p*H 6·0–7·0. The most favourable media are maize or oat paste agar and 2 per cent. malt agar. Synthetic media containing not less than M/250 maltose and $NaNO_3$ or $KNO_3$ as the source of nitrogen support the formation of perithecia by *C. reniformis* and *C. purpurea* but not by *C. sulfurea*. Maltose is a better source of carbohydrate than sucrose.

Perithecia of *C. reniformis* and *C. purpurea* develop abundantly upon fresh, autoclaved wood of beech, oak and ash, but only sparsely upon rotted specimens of these woods or specimens which have been subject to water extraction and partial chlorination. It is difficult to develop the perithecia of *C. sulfurea* either on fresh or rotted wood. The optimum range of atmospheric humidity lies between one-eighth and five-eights of full saturation, and perithecia are usually more plentiful in drier conditions. A very clear optimum range of temperature exists for each species. Linear growth of *C. sulfurea*, though never extensive, is greater between 16 and 18° C., and is negligible at 24° C. Perithecia have so far only been developed upon hard malt agar and oat paste agar between 16 and 18° C. with an air humidity of one-eighth to one-quarter saturation. The relative linear growth and perithecial formation of *C. reniformis* and *C. purpurea* is given in Table II, which shows that the optimum temperature for the former is slightly lower than for the latter. This is quite independent of the medium used.

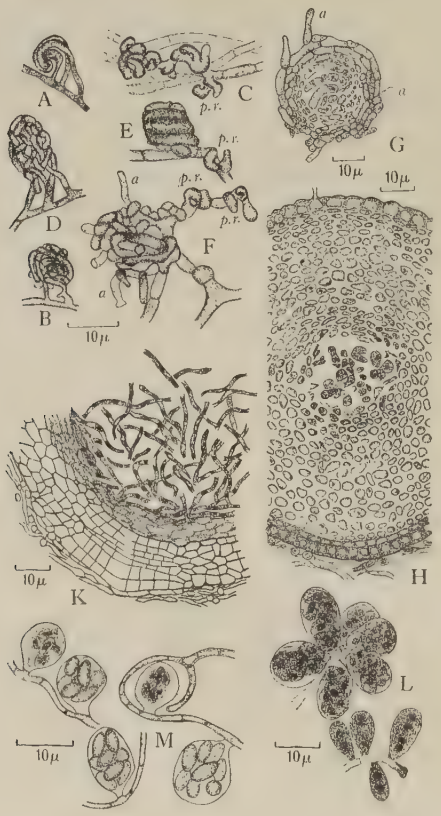
Table II

| Temperature (malt agar) | Linear growth as a % of the optimum value | | Relative abundance of perithecia | |
|---|---|---|---|---|
| | *reniformis* | *purpurea* | *reniformis* | *purpurea* |
| 13 | 68 | 50 | + | 0 |
| 19 | 100 | 87 | +++ | +++ |
| 24 | 99 | 100 | ++ | ++++ |
| 29 | 85 | 99 | 0 | ++ |

+ = few perithecia; ++++ = abundant perithecia.

The perithecial rudiments of the three species are similar and consist of two (Text-fig. 3 C) or, sometimes, three (Text-fig. 3 A) small upright branches which coil loosely round one another to produce an irregular or spherical structure (Text-fig. 3 B–F). They are scattered over the surface mycelium of *C. reniformis* and among the aerial hyphae as well in *C. sulfurea* and *C. purpurea*. As yet it is impossible to say whether the fundaments should be regarded as func-

tional sexual organs. No fusion has been observed between the coiled hyphae. These of *C. reniformis* and *C. purpurea* (Text-fig. 3 A, B, D) are similar and differ in their more delicate construction from those of *C. sulfurea* (Text-fig. 3 C, E, F). The coiled hyphae soon become surrounded by branching filaments which arise from their base (Text-




Text-fig. 3. Stages in the development of the perithecia of *C. purpurea* (A and D), *C. reniformis* (B) and *C. sulfurea* (C, E and F). G, longitudinal section through a young perithecium of *C. reniformis* showing the central spiral hypha and young attachment hyphae (*a*). H, an older perithecium of *C. reniformis* showing the central ascogenous hyphae. K, a sector of the perithecium of *C. sulfurea* showing the loosely woven ascogenous hyphae. L, asci of *C. reniformis*. M, asci of *C. sulfurea*.

fig. 3 B, D). These sterile filaments form the wall of the perithecium and soon become brown. Thus the perithecium is entirely derived from the further growth of two or three fundamental hyphae. At this time, when the outer wall layers are first clearly defined, the perithecium of each species is similar in appearance (Text-fig. 3 G). A double layer of brown, thick-walled cells surrounds a mass of inter-

woven hyphae, in the centre of which lies a single spiral hypha in whose dense finely granular protoplasm prominent nuclei are embedded. The examination of numerous perithecia which were cleared and then stained in erythrosin indicates definitely that only a single hypha is concerned. Subsequent development varies according to the species.

(1) *C. reniformis.*

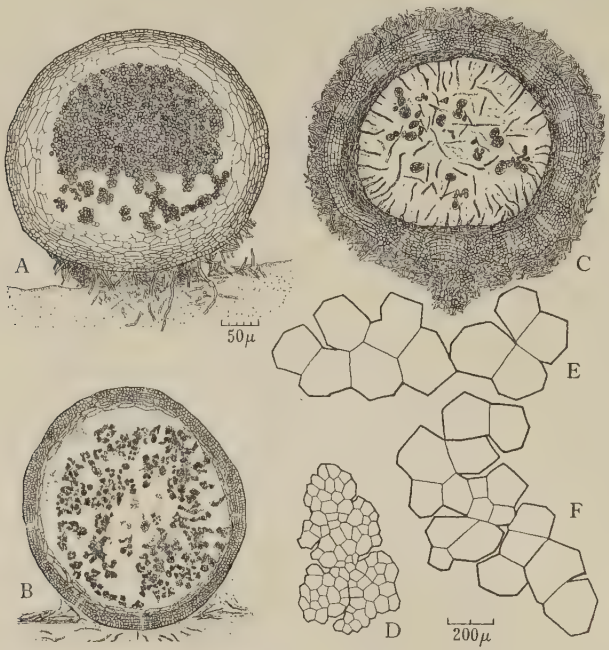
As the perithecium grows, a spherical mass of hyaline pseudoparenchymatous tissue is formed within the dark brown or black wall layers. In the centre of this lie a number of hyphae which stain deeply and often contain paired nuclei (Text-fig. 3 H). They are ascogenous hyphae and are derived from the original spiral hyphae. Increasing in number they become interpolated between the cells of the ground tissue which is ultimately destroyed except for a thin zone adjacent to the outer indurated wall. During this the development of clusters of asci at the apices of the ascogenous hyphae (Text-fig. 3 L) begins and continues until the centre of the perithecium is almost completely filled. The asci are spherical or elliptical, and, being entirely occupied by ascospores, appear sessile. They are evanescent and cannot usually be found in shattered perithecia. They may even have disappeared before normal rupture of the perithecial wall occurs. The eight ascospores are definitely reniform from the time the spore wall is formed, and though at first hyaline they gradually become olive brown and finally fuliginous.

The mature perithecium (Text-fig. 4 A) is a spherical, black, glabrous structure firmly attached to the substratum by brown thick-walled hyphae which are produced at an early stage in development as outgrowths from the hyphae forming the wall (Text-fig. 3 G, *a*). This is about three to five cells in thickness, and in surface view appears to consist of small regular plates (Text-fig. 4 D) of indurated cells separated by a network of thinner walled elements which tear when the perithecium ruptures. As the perithecium dries, and prior to the actual fragmentation, the apical portion generally collapses to form a cup-shaped depression. This was noted by Saccardo in his diagnosis of the species. An apical cap may then be forced off or the whole perithecium may gape in an irregularly two-lipped manner. The basal attached portion usually remains as a cup and is filled with a brown powdery mass of ascospores.

(2) *C. purpurea.*

In this species the development of the ascogenous hyphae and asci (Text-fig. 3 L) is similar to that in *C. reniformis*, except that the asci are smaller and more numerous. The ascospores are bean-shaped, and though ultimately yellowish they remain hyaline for a consider-

able period. The wall of the mature perithecium (Text-fig. 4 B) is from three to four cells in depth. The sutures dividing the wall into polygonal plates (Text-fig. 4 E) have already been referred to (*vide* p. 266). They are built up of tangentially elongated elements whose central cells are not thickened (Text-fig. 5 G). These cells form an almost straight line along which cleavage occurs when the perithecium explodes after drying. This liberates most of the polygonal




Text-fig. 4. Longitudinal sections through the perithecia of: A, *C. reniformis*. B, *C. purpurea*. C, *C. sulfurea*. Segments of the perithecial wall of D, *C. reniformis*. E, *C. purpurea*. F, *C. sulfurea*. (D–F drawn to the same scale with fine lines representing the position of sutures.)

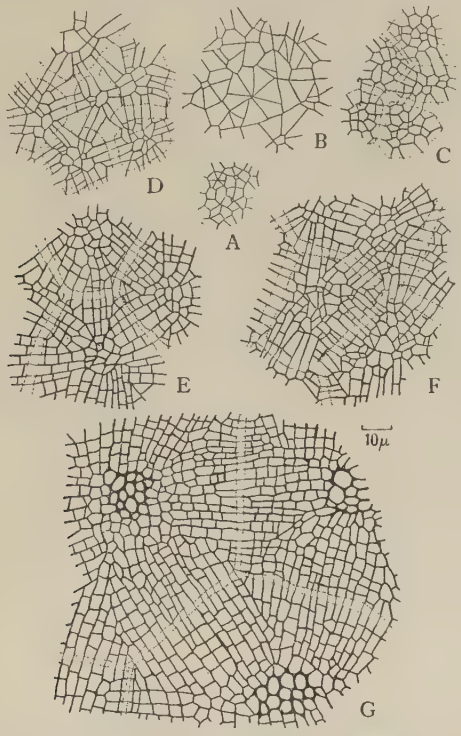
plates in the form of a flat disc of disjointed segments. The majority of the ascospores are dispersed by the explosion, but some remain in groups over the centre of the disc.

The young perithecia of this species seem to be invested by a purple villus. This is due to a pigment developed in the cells of the hyphae in the region of the perithecia and occurs characteristically in cultures exposed to daylight. The villus is not an integral part of each individual perithecium which produces only a few simple attachment hyphae. These seldom persist to maturity. That the purple pigment diffuses into the medium was noted by Shear (*loc. cit.* p. 125) who also

stated that the perithecia are dark purple. I have only occasionally observed this in cultures, and in field collections only that from oak possessed perithecia with definitely pigmented walls.

(3) *C. sulfurea.*

In *C. sulfurea* the ascogenous hyphae occupy practically the whole space within the perithecial wall (Text-fig. 3 K). There is only a thin layer of pseudoparenchymatous tissue lining the wall. The asci first appear towards the centre of the perithecium and are arranged at




Text-fig. 5. Stages in the development of sutures in the perithecia of *C. sulfurea* (A, C, E), *C. reniformis* (B, D, F) and *C. purpurea* (G). (Figures F and G are drawn from mature shattered perithecia but figure E is drawn from a young perithecium. All figures drawn to the same scale).

intervals along the ascogenous hyphae (Text-fig. 3 M). The almost mature perithecium (Text-fig. 4 C) has a relatively wide wall in which suture lines are clearly defined by layers of tangentially elongated thin-walled cells, in a manner similar to those of *C. purpurea* (Text-fig. 5 E). The whole perithecium is covered at this stage by a mass of interwoven, flexuose, thick-walled and sulphur-coloured

hyphae among which occur ordinary hyphae bearing conidia. The sulphur colour may be absent when the perithecia are grown in darkness, but it soon appears on exposure to light. At this time the ascogenous hyphae with their asci are still visible, but as the perithecium matures the former disorganise and only the younger of the latter remain intact, so that the perithecium is filled with clusters of ovoid, brown ascospores among which are a few eight-spored asci. As the perithecium enlarges, its apex becomes glabrous, while its base remains embedded in the mass of sulphur-coloured hyphae. Since the perithecia are formed in clusters, this sulphureous villus is very conspicuous both upon agar media and upon wood. When the perithecium shatters the wall breaks down along the suture lines, discharging the apical series of plates and leaving a basal cup of partially separated plates enclosing the spores.

The presence of definite suture lines in the perithecial wall of the three species of *Cephalotheca* is an important diagnostic character. Whether these sutures are visible, under low-power magnification, on the wall of the perithecium (as in *C. sulfurea* and *C. purpurea*) or not (as in *C. reniformis*) their presence can be demonstrated by suitable preparation. A comparison of their development in the three species shows that in each they are formed by the further growth of certain prismatic or triangular cells (Text-fig. 5 A, B) grouped round a polygonal central cell. The prismatic cells become elongated, and by transverse division (Text-fig. 5 C, D) produce radiating lamellae of thick-walled cells (Text-fig. 5 E, F, G). The central cell gives rise to an indurated plate of cells (Text-fig. 5 G). One or more cells, midway between the lamellae belonging to different plates, remain thin-walled and may represent meristematic cells. Collectively they represent the lines of suture along which the perithecium ruptures. These developmental stages, when considered along with other perithecial characters, indicate a close relationship between the three species.

## IV. Discussion

### (*a*) *The conidial stage*

Considering these three species on the evidence presented in this paper, it appears that the conidia described for *C. reniformis* and *C. purpurea* are homologous and fundamentally differ from the conidia described for *C. sulfurea*. I am of the opinion that a phialospore stage of *C. reniformis* and *C. purpurea* homologous with that of *C. sulfurea*—the type species of the genus—may yet be found.

### (*b*) *The ascophorous stage*

The perithecial rudiments of *C. reniformis* and *C. purpurea* are of similar construction and differ only in size from those of *C. sulfurea*.

In the further differentiation of the perithecium, and particularly of the asci, *C. reniformis* and *C. purpurea* exhibit a closely parallel development which differs only in degree from that of *C. sulfurea*. According to Fuckel the diagnostic characters of the mature astomous perithecium are chiefly the fragile nature of the wall and the clustered arrangement of the asci at the ends of branched ascophorous hyphae. Von Höhnel (4) stated that besides being fragile the perithecia break up along characteristic sutures. The present investigation shows that the sutures in the wall of the perithecium of *C. purpurea* are precisely similar in structure and development to those in the perithecium of *C. sulfurea*. After emending the diagnosis to include von Höhnel's observation, and bearing in mind that *C. sulfurea* is taken as the type species, the only conclusion which can be drawn from the sum of the evidence presented here is that the three species should be generically related.

The coiled fundaments of the perithecium of the species described here are similar to those described by Brefeld for his *Penicillium glaucum* (*Carpenteles asperum* (Langeron) Shear (9)). The formation of the asci upon the ascogenous hyphae may be compared with that described for the *Aspergillus herbariorum* group or for *Penicillium Brefeldianum* (2). There is every reason to believe that *Cephalotheca* should be placed in relation to these genera and that it should be distinguished from them by the specialisation of the perithecium in regard to the liberation of the ascospores.

### (*c*) *Synonymy*

The synonymy of *C. sulfurea* has been discussed by von Höhnel (5). He reviewed the position with regard to two species previously classified as Sphaeropsids and stated that *Aposphaeriopsis fusco-atra* Died. was *C. sulfurea*. He hazarded the view that *Fairmania singularis* Sacc. might be *C. sulfurea* and indicated that he thought *C. reniformis* merely a synonym for *C. sulfurea*. Petrak and Sydow (8), after comparing the type specimen of *Fairmania singularis* in Saccardo's herbarium with *C. sulfurea*, stated that they consider them synonymous. These reports indicate that the two Sphaeropsids should be regarded as species of *Cephalotheca*. Having had the advantage of studying a fungus which closely agrees with the description of *C. reniformis*, I am certain that this species is not synonymous with *C. sulfurea*. The latter has a *sulphur-coloured villus* surrounding the perithecium and ovoid ascospores measuring $6 \times 4\mu$. *C. reniformis* has a *glabrous* perithecium and reniform ascospores measuring $4–5 \times 3–3{\cdot}8\mu$. Diedicke describes *Aposphaeriopsis fusco-atra* with a *glabrous* fructification (200–250$\mu$ in diameter) containing spores measuring 4–5$\mu$ in diameter which are drawn as reniform (Pl. XII, fig. 5). These characters indicate that it is *C. reniformis* and not *C. sulfurea*. The spores of

*Fairmania singularis* are described as (Saccardo, *loc. cit.* p. 276): "Solae calcaneum exacte imitantis" (exactly like the heel of a slipper). At first hyaline, they later become sooty and measure 5·7$\mu$ in diameter. Since Petrak and Sydow consider *Fairmania singularis* a good *Cephalotheca*, these characters indicate that it should be held synonymous with *C. reniformis*.

## V. Summary

### A. *Diagnosis of* Cephalotheca

1. *Perithecia* astomous, simple, spherical, carbonaceous, fracturing at maturity along well-defined sutures; young perithecia sometimes covered by a coloured villus, in other species totally glabrous; on dry decayed wood, superficial or semi-immersed and free, or immersed and attached basally. Asci spherical or elliptical, on branched ascogenous hyphae, alternate or clustered, more or less sessile, eight-spored, evanescent. Ascospores conglobate, ovate or bean-shaped or reniform, continuous, hyaline to yellow or fuscous (light to dark brown in mass).

2. *Conidia* formed upon a white or slightly coloured mycelium. Conidia hyaline, continuous, either serial phialospores, ovate or broadly elliptical, or radulospores, falcate or suballantoid.

Type species: *C. sulfurea*.

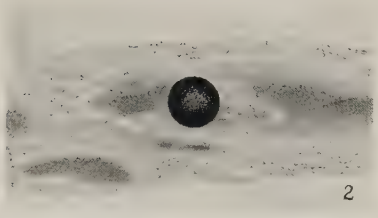
### B. *Key to the accepted species of* Cephalotheca

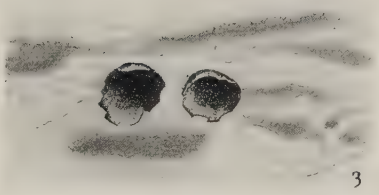
(*a*) *Ascospores ovate.*
Perithecia surrounded by a sulphureous villus.
Ascospores 6 × 4$\mu$. Phialospores 3–5 × 2–3$\mu$. ***C. sulfurea.***

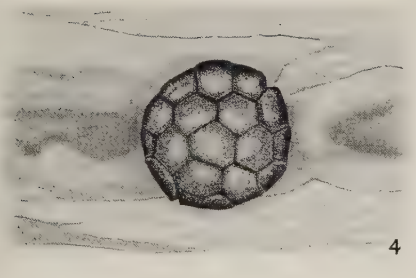
(*b*) *Ascospores ± reniform.*
(i) Perithecia partly invested with a transitory purple coloured villus. Ascospores bean-shaped 2·3–3·0 × 1·5–2·0$\mu$. Radulospores 3–4 × 1·5$\mu$. ***C. purpurea.***
(ii) *Perithecia* totally glabrous, attached basally to the substratum. Ascospores reniform 4–5 × 3·0–3·8$\mu$. Radulospores 4–5 × 1·5$\mu$. ***C. reniformis.***

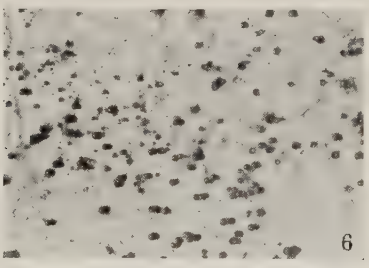
I desire to express my gratitude to Mr E. W. Mason, of the Imperial Mycological Institute, Kew, not only for suggesting this investigation and for providing material but also for his continued help and criticism throughout its course. The kind assistance of Dr C. L. Shear, of Washington, U.S.A., made it possible to place the type species of *Fragosphaeria* exactly. To Mr W. B. Grove, of Birmingham, I am deeply indebted for the collection of *C. sulfurea* which rendered a thorough comparison between the type species of the two genera

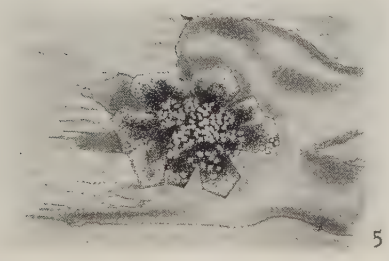
B
C
A
D
1


2


3


4


6


5

7

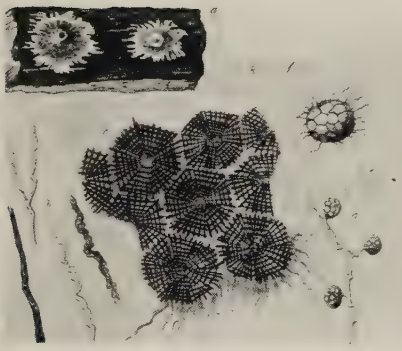


Fig. 1

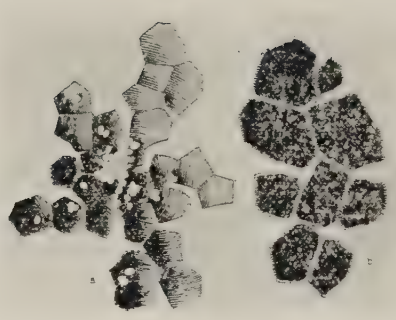


Fig. 2

Fig. 3

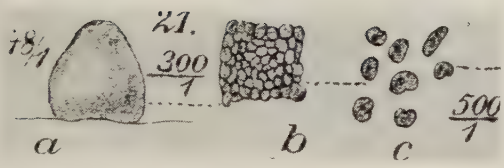



Fig. 5

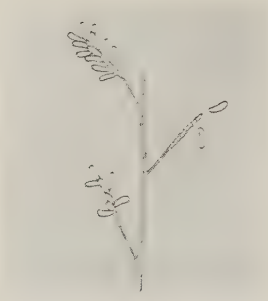


Fig. 4

possible. My thanks are also due to Mr J. Ramsbottom and Miss E. M. Wakefield for affording facilities for the inspection of Herbarium material.

## REFERENCES

(1) Berkeley, M. J. and Broome, C. E. "Notices of British Fungi, No. 1729." *Ann. Mag. nat. Hist.* Ser. 5, 1 (1878), 30 and Pl. IV, fig. 8.
(2) Dodge, B. O. "The perithecium and ascus of *Penicillium*." *Mycologia*, xxv (1933), 90–104.
(3) Fischer, E. "Plectascineae." In Engler and Prantl, *Nat. Pflanzenf.* 1, 1 (1897), 278–320.
(4) Höhnel, F. V. "Mycologisches." *Öst. bot. Z.* lxvi (1916), 53, No. 31.
(5) —— "Mycologische Fragmente." *Ann. Mycol.*, Berl., xv (1917), 360.
(6) Mason, E. W. *Annotated Account of Fungi Received at the Imperial Mycological Institute*, List II, fasc. 2 (1933).
(7) Nannfeldt, J. A. "Studien über die Morphologie und Systematik der nichtlichenisierten inoperculaten Discomyceten." *Nova Acta Soc. Sci. Upsal.* Ser. iv, 8 (1932), 29–31.
(8) Petrak, F. and Sydow, H. "Die Gattungen der Pyrenomyceten Sphaeropsideen und Melanconieen." *Repert. nov. Spec. Regn. Veg.* xlii, Beih. 3 (1927), 489.
(9) Shear, C. L. "*Penicillium glaucum* of Brefeld (*Carpenteles* of Langeron) refound." *Mycologia*, xxvi (1934), 104.
(10) Winter, G. In Rabenh. *Krypt. Fl.* 1, Abt. ii (1884), 55.

## EXPLANATION OF PLATES XI and XII

### Plate XI

Fig. 1. Perithecia of *Cephalotheca sulfurea* in various stages of development.
Fig. 2. Mature perithecium of *C. reniformis* on beech wood.
Fig. 3. Shattered perithecia of *C. reniformis*.
Fig. 4. Mature perithecium of *C. purpurea* showing suturing.
Fig. 5. Shattered perithecium of *C. purpurea* showing clustered groups of ascospores.
Fig. 6. Perithecia of *C. reniformis* developed on a culture of beech wood.
Fig. 7. Perithecia of *C. purpurea* on a similar culture.

### Plate XII

Reproductions of drawings of species of *Cephalotheca*.
Fig. 1. *C. sulfurea* (Berkeley and Broome, 1878).
Figs. 2–4. *C. purpurea* (Shear, 1923).
Fig. 5. *Aposphaeriopsis fusco-atra* (Diedicke, 1913).
For further explanation see text.

While this paper was in press an extensive collection of *Cephalotheca sulfurea* was made at Birmingham on structural timber which had been covered by ashes. The mycelium bore both phialospores and mature perithecia. There now seems to be little doubt that this species is a "domestic mould" occurring superficially upon a variety of woods.

# THE FUNGI OF WICKEN FEN, CAMBRIDGESHIRE

By E. J. H. CORNER, M.A.

This preliminary list of about 250 fungi includes most of the common species which are to be found each year on the Fen and several which are interesting either for their rarity or their unusual occurrence; yet it is far from complete. I visited the Fen during the years 1924–8 and at most seasons except the early autumn, and collected chiefly the Basidiomycetes, the list of which is fairly representative. That of the Ascomycetes is meagre, however, because of the difficulty of identification, though, in fact, as Pyrenomycetes and inoperculate Discomycetes, they are exceedingly abundant. Neither Fungi Imperfecti nor Mycetozoa were collected. Probably no less than 700 species of fungi will be found on the Fen.

The absence of woodland precludes the occurrence of most species with large fruit bodies, so that even in autumn fungi are not obvious and must be looked for. But the Fen offers the mycologist two interesting habitats. Under the willow and alder are low mounds of earth, bare or but thinly covered with fallen leaves and, in places, with rotting clumps of sedges which have died in the shade: this earth is dark, rich, friable and light in weight, and consists almost entirely of vegetable remains comminuted and voided by woodlice. Here the larger toadstools occur, such as *Inocybe*, *Leptonia*, *Mycena*, *Psathyra*, *Psathyrella*, *Russula violacea*, *Hygrophorus conicus*, *Tricholoma melaleucum*, *Naucoria escharoides*, and the terricolous Discomycetes *Aleuria*, *Galactinia*, *Ciliaria*, *Pulvinula*, and *Sepultaria*: on the dead stumps and branches occur the lignicolous species of *Polyporus*, *Stereum*, *Corticium*, etc. Then, in the Fen itself, the remains of herbaceous plants and the tussocks of dead matted leaves of grasses and sedges support the smaller Basidiomycetes and microfungi in such vast numbers that the air is dusty with their spores. *Marasmius ramealis* and *Omphalia integrella* develop in troops indiscriminately on these remains; *Androsaceus graminum*, *Coprinus Friesii* and *Pistillina Patouillardii* have a preference for the haulms of *Phragmites*, and *Marasmius Menieri*, *Omphalia gibba* and *Pistillaria aculeata* for the leaf-bases of *Cladium Mariscus*. *Psathyra Typhae* grows on the dead haulms of *Phragmites* and *Scirpus* standing in water and, like *Coprinus Friesii*, the fruit-bodies develop even at the water's surface. *Omphalia candida* is found only on the dead leaf-bases of *Symphytum officinale*, although on turning aside the living leaves between July and October it can be seen that nearly every plant is infected. These Basidiomycetes fruit generally in late summer and

autumn. In the spring and early summer and again in autumn, to a lesser extent at other times of the year, inoperculate Discomycetes of the genera *Mollisia*, *Helotium*, *Dasyscypha*, etc., cover the herbaceous remains with their minute apothecia in profuse variety, and Pyrenomycetes, though less conspicuous, are even more abundant. Both habitats are ideal for the growth of fungi: vegetable remains abound and soil and air are almost continuously damp and little disturbed by the winds. The fungi rot the dead plants, turning them into living spores which floating round settle down as manna for the microscopic animals.

In the early summer the fruit-bodies of *Mitrula sclerotipus* and *Claviceps microcephala* develop in great numbers throughout the Fen, the one on the dead stems of grasses and the other on the dead inflorescences particularly of *Phragmites*: the aecidial stage of *Puccinia coronata* becomes almost epidemic on the buckthorn, rendering the bushes most unsightly. In midsummer, *Melampsorella Symphyti* covers the underside of the leaves of *Symphytum officinale* with an orange powder of uredospores. In autumn *Typhula phacorrhiza* takes the place of *Mitrula sclerotipus*, its thread-like fruit-bodies forming miniature forests, and *Pistillina Patouillardii* swarms over the dead remains of *Phragmites*. It may be that the sclerotial species of *Mitrula* and *Typhula*, like *Claviceps* and *Sclerotinia*, have special life histories.

Remarkable is the presence of the underground puffball, *Hymenogaster tener*, which generally grows in the deep humus of beechwoods. It is in the carr on the east of the Burwell end of the main drove.

As rarities only *Puccinia bullata*, which is confined to its rare host *Peucedanum palustre*, and *Pistillina hyalina* can be reckoned. *P. hyalina* I found once, in February 1925, on a dead grass stem half-way along the main drove: it is a unique species hitherto known only from Quélet's original gathering in France some fifty years ago, and worthy of a distinct genus. There is also a second species of *Mitrula* with a minute sclerotium and very slender light brown fruit-bodies, which develop in June among the rushes; it is certainly new to science.

*Marasmius Menieri*, *Psathyra Typhae*, *Pistillaria aculina* and *P. aculeata* are recorded here for the first time for Great Britain, and the recent records of *Omphalia candida*, *O. gibba*, *Pistillina hyalina* and *P. Patouillardii* are from Wicken Fen and district. Apart from *P. hyalina*, all are fairly common and widespread in such localities. But many strange fungi and rarities are to be discovered in the fens. The species of *Pistillaria*, particularly those on herbaceous remains, are little known and would repay study; and one should look also for aquatic fungi, Laboulbeniaceae and other entomogenous groups.

The nomenclature adopted in this list is that of the standard works cited in the bibliography, and in their sense the species have been taken. As regards the newly recorded species, I have appended with

a few critical notes descriptions from material collected on the Fen.

In conclusion, I must express my indebtedness to Mr Carleton Rea for his invaluable assistance in revising the manuscript and kindly confirming the more difficult identifications.

## BASIDIOMYCETES

### Homobasidiae

Acia denticulata (Pers.) Bourd. & Galz., uda (Fr.) Bourd. & Galz.
Androsaceus graminum (Lib.) Pat.
Annellaria separata (L.) Karst., on horse-dung with other coprophilous species.
Bolbitius vitellinus (Pers.) Fr., in the grass by the main drove.
Claudopus byssisedus (Pers.) Fr., on earth, stems, mosses, etc., variabilis (Pers.) W. G. Sm.
Clavaria tenuipes B. & Br., common on sticks and bare ground in the fen.
Coprinus cordisporus Gibbs, ephemerus (Bull.) Fr., Friesii Quél., common on *Phragmites*, *Cladium*, etc., niveus (Pers.) Fr., plicatilis (Curt.) Fr.
Corticium confluens Fr., flavescens (Bon.) Mass., Sambuci (Pers.) Fr.
Cortinarius flexipes Fr., in the carr.
Cyphella capula (Holmsk.) Fr., capula var. flavescens Pat., lactea Bres., common on dead grass leaves.
Eccilia griseo-rubella (Lasch) Fr.
Epithele Typhae (Pers.) Pat., common.
Galera hypnorum (Schrank) Fr., tenera (Schaeff.) Fr.
Grandinia mutabilis (Pers.) Bourd. & Galz.
Hygrophorus conicus (Scop.) Fr.
Hymenogaster tener Berk.
Hypholoma appendiculatum (Bull.) Fr., especially where scrub had been cut down and sticks heaped.
Hypochnus fuscus (Pers.) Fr., granulosus (Peck) Burt., roseo-griseus Wakef. & Pears., on dead *Cladium* leaves.
Inocybe geophylla (Sow.) Fr., under bushes, geophylla var. fulva Pat., on the ground in the sedge-fen, rimosa (Bull.) Fr., sensu Rea.
Irpex obliquus (Schrad.) Fr.
Leptonia asprella Fr., sericella (Fr.) Quél., serrulata (Pers.) Fr. var. laevipes Maire.
Marasmius Menieri Boud. (see description at the end of list), ramealis (Bull.) Fr.
Mycena acicula (Schaeff.) Fr., corticola (Schum.) Fr., filopes (Bull.) Fr., metata Fr., vitilis Fr.
Naucoria cerodes Fr., effugiens Quél., escharoides Fr., graminicola (Nees) Fr.
Omphalia candida Bres., only on *Symphytum officinale*, gibba Pat., common on *Cladium*, rarely on willow leaves, gracilis Quél., grisea Fr., integrella (Pers.) Fr., common on dead twigs, leaves, haulms, etc., muralis (Sow.) Fr., stellata Fr.
Panaeolus campanulatus (L.) Fr., papilionaceus (Bull.) Fr., sphinctrinus Fr.
Peniophora cinerea (Fr.) Cke., detritica, Bourd., forming large patches on dead leaves of *Cladium*, incarnata (Pers.) Cke., longispora (Pat.) v. Hoehn. & Litsch., frequent on sticks and haulms.
Pistillaria aculeata Pat. (see description at end of list), aculina (Quél.) Pat. (see description at end of list), micans (Pers.) Fr., pusilla (Pers.) Fr., uncialis (Grev.) Cost. & Dufour, on dead herbaceous stems.
Pistillina hyalina Quél., Patouillardii Quél.
Pluteus hispidulus Fr. (see description at end of list), nanus (Pers.) Fr. var. lutescens Fr., on sticks and *Phragmites* stems.
Polyporus betulinus (Bull.) Fr., on the old birch tree, nummularius (Bull.) Quél., picipes Fr., varius Fr.

Polystictus versicolor (L.) Fr.
Poria vulgaris Fr., sensu Rea.
Psathyra bifrons B., gossypina (Bull.) Fr., Typhae Kalchbr. (see description at end of list).
Psathyrella atomata Fr., disseminata (Pers.) Fr., gracilis Fr.
Psilocybe bullacea (Bull.) Fr., foenisecii (Pers.) Fr., inquilina (Fr.) Bres.
Russula violacea Quél. under *Cornus*.
Solenia anomala (Pers.) Fr.
Stereum hirsutum (Willd.) Fr., purpureum (Pers.) Fr.
Tricholoma melaleucum (Pers.) Fr., small specimens on the remains of *Cladium* in the carr.
Tubaria furfuracea (Pers.) W. G. Sm.
Typhula candida Fr., erythropus (Bolt.) Fr., Grevillei Fr., gyrans (Batsch) Fr., phacorrhiza (Reichb.) Fr.

### Heterobasidiae

Coleosporium Rhinanthacearum Lév., Senecionis Fr., Sonchi Lév., Tussilaginis Tul.
Doassansia Sagittariae (West.) Fisch.
Exidia nucleata (Schw.) Rea.
Melampsorella Symphyti Bubák.
Phragmidium disciflorum James.
Puccinia bromina Erikss., bullata Wint., Centaureae DC., Cirsii Lasch, Cnici-oleracei Pers., coronata Corda, Glechomatis DC., holcina Erikss., Hypochaeridis Oud., Lolii Niels., Magnusiana Körn., Menthae Pers., obtegens Tul., Orchidearum-Phalaridis Kleb., persistens Plowr., Phragmitis Körn., Poarum Niels., pulverulenta Grev., Taraxaci Plowr.
Sebacina fugacissima Bourd. & Galz.
Tremella mesenterica (Retz.) Fr.
Triphragmium Ulmariae Wint.
Urocystis Anemones (Pers.) Wint.
Uromyces Fabae de Bary, Junci Tul., Polygoni Fuck., Rumicis Wint.
Ustilago longissima (Sow.) Tul.

## ASCOMYCETES

### Discomycetes

Aleuria vesiculosa (Bull.) Boud.
Ascobolus furfuraceus Pers.
Ascophanus carneus (Pers.) Boud., ochraceus (Cr.) Boud.
Belonidium vexatum de Not.
Belonium excelsius (Karst.) Boud., filisporum (Cke.) Sacc.
Calycella citrina (Hedw.) Quél., claroflava (Grev.) Boud., uliginosa (Fr.) Boud.
Catinella olivacea (Batsch.) Boud.
Cheilymenia dalmeniensis (Cke.) Boud.
Ciboria amentacea (Balb.) Fuck.
Ciliaria asperior (Nyl.) Boud., hirta (Schum.) Rehm, scutellata (L.) Quél.
Coprobia granulata (Bull.) Boud.
Coryne sarcoides (Jacq.) Tul.
Cyathicula coronata (Bull.) de Not.
Dasyobolus immersus (Pers.) Sacc.
Dasyscypha acutipila (Karst.) Sacc., bicolor (Bull.) Fuck., calyculaeformis (Schum.) Rehm, controversa (Cke.) Rehm, crucifera (Phill.) Sacc., crystallina (Fuck.) Sacc., patens (Fr.) Sacc., rosea Rehm, spiraeaecola (Karst.) Sacc., virginea (Batsch) Fuck.
Dermatea Frangulae (Fr.) Tul.
Encoelia furfuracea (Roth.) Karst.
Erinella hapala (B. & Br.) Sacc., Nylanderi Rehm.
Galactinia badia (Pers.) Boud., succosa (Berk.) Sacc.

Helotium amenti Fuck., cyathoideum (Bull.) Karst., eburneum (Desm.) Gill., epiphyllum (Pers.) Fr., gramineum Phill., herbarum (Pers.) Fr., phyllogenum Rehm, phyllophilum (Desm.) Karst., salicellum (Hazl.) Fr., scutula (Pers.) Karst, tetra-ascosporum Rea, virgultorum (Wallr.) Karst.
Heterosphaeria patella (Tode.) Grev.
Hyalinia inflatula (Karst.) Boud.
Hyaloscypha hyalina (Pers.) Boud.
Lachnea hemisphaerica (Wigg.) Gill.
Lachnella albotestacea (Desm.) Quél., canescens (Phill.) Cke., leucophaea (Pers.) Boud., sulfurea (Pers.) Quél.
Lasiobolus equinus (Mull.) Karst.
Micropodia dumorum (Desm.) Boud.
Mitrula sclerotipus Boud. (see description at end of list).
Mollisia atrata (Pers.) Karst., benesuada (Tul.) Phill., cinerea (Batsch) Karst., juncina (Pers.) Rehm, melatephra (Lasch) Karst.
Niptera lacustris Fr., pulla (Phill. & Keith) Boud.
Ombrophila clavus (A. & S.) Cke., imberbis (Bull.) Boud., verna Boud.
Orbilia leucostigma Fr., xanthostigma Fr.
Phacidium Calthae Phill.
Phialea bolaris (Batsch) Quél.
Polydesmia pruinosa (B. & Br.) Boud.
Pseudopeziza Trifolii (Biv.-Bern.) Fuck.
Pyrenopeziza millegrana Boud.
Pulvinula constellatio (Cke.) Boud.
Sclerotinia Curreyana (Berk.) Karst., Duriaeana (Tul.) Quél.
Sepultaria arenicola (Lév.) Mass.
Tapesia evilescens (Karst.) Sacc., fusca (Pers.) Fuck., retincola (Rabenh.) Karst., common on dead haulms of *Phragmites*.
Trichopeziza carinata Cke., & Mass., Grevillei (Berk.) Sacc.
Urceolella deparcula (Karst.) Boud., effugiens (Desm.) Boud., leucostoma (Rehm) Boud., scrupulosa (Karst.) Boud.

### Pyrenomycetes

Anthostomella tomicum (Lév.) Sacc.
Calonectria xantholeuca (Kunze) Sacc.
Claviceps microcephala (Wallr.) Tul.
Coleroa Chaetomium (Kunze) Rabenh.
Didymosphaeria commanipula (B. & Br.) Niessl.
Erysiphe Cichoracearum DC., communis (Wallr.) Fr., graminis DC., Martii Lév.
Leptosphaeria doliolum (Pers.) Ces. & de Not.
Lophiostoma caulium (Fr.) de Not, microstomum Niessl, semiliberum (Desm.) Ces. & de Not.
Massaria eburnea Tul.
Nectria cinnabarina (Tode) Fr., coccinea (Pers.) Fr.
Ophiobolus herpotrichus (Fr.) Sacc.
Phyllachora graminis (Pers.) Fuck.
Pleospora herbarum (Pers.) Rabenh.
Sphaerotheca pannosa (Wallr.) Lév.
Trematosphaeria mastoidea (Fr.) Rabenh.
Valsa lata (Pers.) Nits.
Venturia Rumicis (Desm.) Rabenh.

## PHYCOMYCETES

Cystopus candidus (Pers.) Lév.
Peronospora alta Fuck., effusa Rabenh., nivea Unger, parasitica (Pers.) Tul., Urticae Casp.
Phycomyces nitens Kuntze.

***Marasmius Menieri*** Boud. in *Bull. Soc. mycol. Fr.* (1894), p. 61.

Pileus 2–6 mm. wide, 120–250$\mu$ thick, convex then *plane*, sometimes subconcave, rarely subumbonate, *circular or almost spathulate, puberulous*, even or subreticulate, not striate, *white to pale yellowish or brownish*: margin straight at first, often becoming slightly inflexed. Stem 2–10 mm. long, 0·3–0·8 mm. thick at the base, 0·15 mm. at the apex, *central or slightly excentric, generally more or less horizontal and pressed against the hymenium*, rarely vertical, *attenuate upwards from the abrupt swollen base, puberulous below*, glabrous above, *white at the apex, ferruginous downwards, dark brown or black at the base*. Hymenium *plane or with a few shallow folds or wrinkles, white or cream-coloured*. Flesh very thin, slightly gelatinous over the hymenium, pallid. Spores 13–23 × 4–5·5$\mu$, white, smooth, fusiform pip-shaped, thin-walled: clouded vacuolate. Basidia 40–55 × 9–11$\mu$, with 4, rarely 2, sterigmata, 4–5$\mu$ long. Cystidia absent from the hymenium. On decayed leaves of *Cladium Mariscus* and *Typha*, July–Oct.; common in the fens.

The upperside of the pileus is covered with a compact palisade of a single layer of clavate or ventricose cells, 25–80 × 12–30$\mu$, with slightly thickened, pale yellowish brown, even walls, often more or less encrusted, which give the colour to the pileus. There are also, in this layer, numerous ventricose pilocystidia, 50–120 × 6–18$\mu$, with thin, smooth, colourless walls and prolonged distally into a straight filiform appendage, 1·5–2·5$\mu$ wide. The caulocystidia are of two kinds, either like the pilocystidia and ventricose or subtriangular below with filiform apex, or like the palisade cells of the pileus but more irregular and narrower, cylindric to clavate and capitate, rarely encrusted, 30–70 × 5–20$\mu$, with darker brown walls, giving the colour to the stem.

Boudier states that there may be shallow gills: there were none in the Fen specimens, the folds and wrinkles of the hymenium corresponding with furrows on the pileus and not formed by a downgrowth of hyphae. When growing from a vertical surface, as from the leaf-bases of *Cladium*, the stem appears lateral because it is pressed tight against the hymenium.

***Pistillaria aculeata*** Pat. *Tab. Anal.* No. 58.

R. 1–2 mm. high, 40–90$\mu$ thick, *with a distinct, glabrous stem*, 0·2–0·4 mm. long, *minute, filiform*, simple, not swollen at the base, *attenuate at the apex, white*. Hymenium loose, generally leaving a sterile apex, rarely continuous over the apex. Spores 4–6 × 2–3$\mu$, white, smooth, ellipsoid, slightly flattened on the inside, with thin walls and clouded contents. Basidia 8–16 × 3·5–5$\mu$, subclavate with 4, rarely 2, sterigmata, 3–6$\mu$ long, not forming a compact layer. Cystidia none. Hyphae 1–2·5$\mu$, with clamps. Densely gregarious on dead leaf-bases of *Cladium Mariscus*, July–Nov.; common.

*Pistillaria graminicola* differs in the hairy stem and larger spores. *P. Queletii* Pat. differs in being sessile and having cystidia. *P. acuminata* Fuck. differs in the thicker, squat receptacle and much smaller spores. *P. mucedinacea* Boud. has narrower, subcylindric spores, according to Bourdot and Galzin (*Hym. Fr.* p. 137), and is lignicolous, though in other respects exceedingly similar. As noted by Bourdot and Galzin (*loc. cit.* p. 140), the receptacle may or may not have a sterile apex according to its state of development.

***Pistillaria aculina*** (Quél.) Pat.; *Quél.* in *Ass. Fr.* (1880), p. 10.

R. 3–10 mm. high, 0·1–0·3 mm. thick, *small, acicular, attenuate to the filiform apex*, rarely subcylindric with obtuse abrupt apex, *sessile* or indistinctly stipitate, simple, *white*; base slightly dilated, often brownish. Hymenium compact, continuous from the base to some distance short of the apex which projects as a sterile point, rarely continuous over the apex, sometimes lacking at the extreme base. Spores 9–13 × 6–7$\mu$, white, smooth, ellipsoid, slightly flattened on the inside, with thin walls and

clouded contents. Basidia 20–28× 7–9μ, clavate, with 2 sterigmata, 4–5μ long. Cystidia 25–40× 5–8μ, frequent, varying from sterile basidia, narrowed at the apex, to subventricose, elongate cells with bluntly tapered apex. Hyphae 1·5–3μ, with clamps. Gregarious on dead haulms of grasses, sedges and rushes, Oct.–Nov.; common in the fens.

This species differs from *P. aculeata* in the larger, sessile receptacles, the larger spores, the 2-spored basidia and the presence of cystidia. The numerous subspecies described by Bourdot and Galzin (*Hym. Fr.*, pp. 138, 139) may also be found on the Fen.

***Pluteus hispidulus*** Fr.; Konr. & Maubl. *Ic. Select. Fung.* t. 25, f. 1.

Not uncommonly, scattered on the ground in the carr, are to be found the fruit-bodies of a Pluteus which Rea would refer to *P. hispidulus* Fr., *sensu* Konrad and Maublanc, with whose description and figure it well agrees. The pileus is darker and much more villous, however, than one would imagine from Fries's description and it is always terrestrial (I have found it on Chippenham Fen also, and in Bucks). On the other hand it agrees exactly with *P. exiguus* Pat. (*Tab. Anal.* No. 425) apart from the spores which Patouillard gives as 6–7 × 3μ. *P. murinus* Bres. is close but has much larger fruit-bodies with paler and less villous pilei. *P. plautus* differs in the dark villous stem and *P. cinereus* in the white furfuraceous stem. I append a description of the fungus from Wicken Fen by which it may be recognised and finally determined.

Pil. 1–2 cm., convex becoming plane, finally often depressed in the centre, *at first wholly mouse-grey, fuliginous fuscous or blackish brown and velvety-villous*, with the disc darker and often umber-black, *developing a ruddy tinge towards the margin as the pileus expands and the villosity breaking up into minute erect umber-black scurfy squamules*, 0·3–0·5 mm. high, except at the disc which remains evenly villous: margin straight, becoming slightly sulcate over the gills, not striate. Stem 3–3·5 × 0·15–0·2 cm., cylindric, hollow, brittle, *shining watery white to silvery grey, silky fibrillose with a few darker, fuscous fibrils especially towards the abrupt slightly swollen white villous base*. Gills free or just adnexed, ventricose, crowded, 3–3·5 mm. wide, 1–2 ranks, white then pink. Flesh thin, watery white; smell none. Spores pink subglobose, smooth, 5–7 × 5–6μ. Basidia 20–30× 7–9μ, with 2–4 sterigmata. Cystidia only on the gill-edge, not forming a sterile edge, vesiculose, clavate or ventricose, often prolonged into a short appendage, not hooked, thin-walled, colourless, 35–60× 9–13μ. On wet earth rich in humus. June–Sept.; frequent on the Fen.

The hyphae forming the villosity of the pileus are in a pile perpendicular to the surface and composed of several cells, 40–150× 8–30μ with dark brown sap, the terminal cell varying from clavate to ventricose.

***Psathyra Typhae*** Kalchbr. *Gomb.* p. 206, t. 1, fig. 1, and *Psathyra Typhae* var. *Iridis* Boud. in *Bull. Soc. mycol. Fr.* XIII (1897), 13, t. 1, Fig. 3.

Pileus 1–1·5 cm., convex then flattened, sometimes depressed in the centre, *disc sometimes vaguely reticulate*, otherwise smooth and even, *striate, hygrophanous, watery fuscous fawn to watery cinnamon, darker at the disc when moist, drying* pallid fuscous tan and *minutely atomate*; margin straight. Veil thin, fugacious, as a few brownish fibrils round the margin of the pileus and fibrils on the stem, sometimes forming a faint arachnoid ring on the stem. Stem 2–3 cm.× 1–1·5 mm., *brittle*, cylindric, *somewhat white fibrillose* in the lower half, apex slightly striate, *pallid with a faint tinge of brown; base abrupt, swollen*, 3–4 mm. wide, *white villous*. Gills *rounded adnexed, separating free* sub-distant, 2–2·5 mm. wide, *pallid white then fawn*. Flesh very thin, concolorous, fragile. Spores 10–13× 6–7·5μ, fuscous fawn in the mass, yellowish fuscous under the microscope, smooth, elliptic more or less deformed on one side, rarely sub-

triangular, eguttate. Basidia 27–40× 10–14$\mu$ with 4 sterigmata. Cystidia only on gill-edge forming a sterile edge, clavate, cylindric or more or less ventricose, often curved or flexuous, thin-walled, colourless, 20–50× 8–16$\mu$. On dead stems and leaves of *Phragmites*, *Carex*, *Scirpus*, in wet places, often just above the water-level on leaf-bases attached to the dead standing stems. July–Sept. Fens, Cambridgeshire.

***Mitrula sclerotipus*** Boud. in *Bull. Soc. bot. Fr.* (1877), 309, t. IV, Fig. V; *Icon. Mycol.* III, pl. 428, IV, 245; *Trans. Brit. mycol. Soc.* III, 378.

Very small, 1·5–2 cm. long, yellowish ferruginous, club oblong, shorter than the stem. Club elongate, club-shaped, generally narrower at the base, separated from the stem by a distinct groove, solid, flesh white or concolourous when moist. Stem stuffed, simple, occasionally bifurcate or trifurcate, springing from a well developed sclerotium. Paraphyses shorter than the asci, hyaline, granular inside. Asci fusiform, 45–50× 5–7$\mu$. Spores 10–13× 3–3·5$\mu$, filled with multigranular protoplasm. On the ground in marshy woods. June. Common in the Fen.

## REFERENCES


Boudier, E. *Histoire et Classification des Discomycètes d'Europe* (1907).
Grove, W. B. *The British Rust Fungi* (1913).
Rea, C. *British Basidiomycetae* (1922).
—— Appendix. *Trans. Brit. mycol. Soc.* XII (1927).
—— Appendix II. *Trans. Brit. mycol. Soc.* XVII (1932).
—— "New or rare British Discomycetae." *Trans. Brit. mycol. Soc.* VII (1922), 58; XIII (1928), 253.
—— "New or rare British Fungi." *Trans. Brit. mycol. Soc.* VI (1920), 322.
Winter, G. Rabenhorst's *Kryptogamen Flora*, I (Pyrenomycetes) (1887).

# NOTES ON THE OCCURRENCE OF *PYRENOPHORA AVENAE* ITO, IN SCOTLAND

By R. W. G. DENNIS, Ph.D.

(With 9 Text-figures)

In some notes(1) recently compiled on the *Helminthosporium* disease of oats in Scotland it was pointed out that although the perfect stage of the fungus had been reported by Rathschlag(4) in Germany, and by Ito(3) in Japan, it had not been found in this country. Attention was also drawn to the fact that discrepancies exist between the descriptions furnished by these authors, and it was suggested that the findings of Ito might be inapplicable to European conditions.

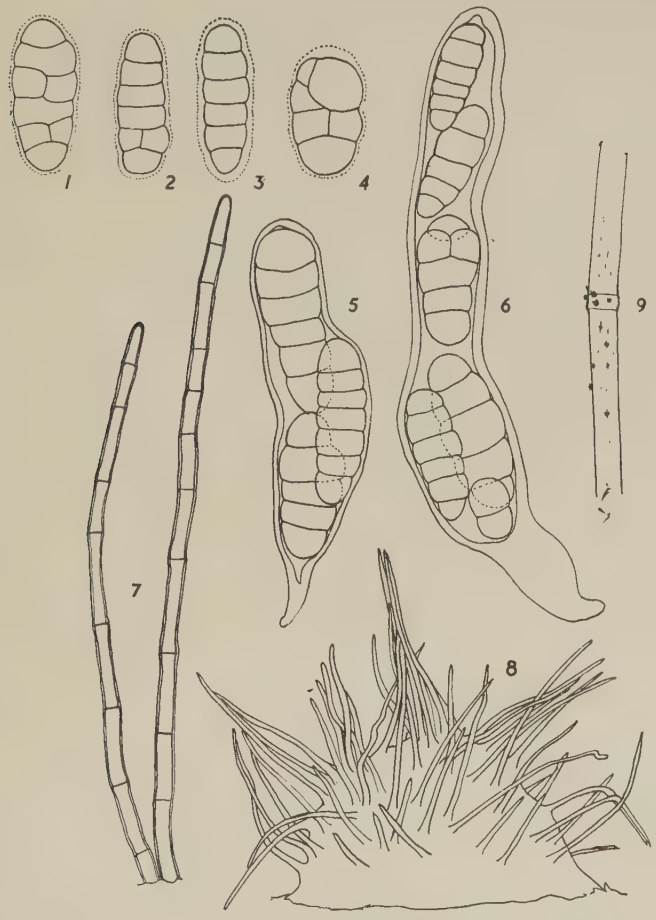
Since the above paper was written perithecia associated with *Helminthosporium Avenae* have been discovered in Scotland. Unfortunately, as in the closely related *Pyrenophora teres* described by Drechsler(2), the majority of the asci have remained immature. Sufficient material however, is available to indicate that the fructifications correspond closely with the diagnosis furnished by Ito, and differ widely from the structures obtained under cultural conditions by Rathschlag.

Perithecia were first observed on January 16th, 1934, on stubble of King Oat sown out with grass at Auchincruive, Ayrshire. Specimens were scarce at this period, a collection of 283 stems showed only 8, or 2·9 per cent., with fructifications, and of these only one contained mature ascospores. Single spore cultures were at once made from these, and exhibited the peculiar tufted development of aerial mycelium characteristic of *H. Avenae*. *Helminthosporium* spores were being produced freely on these cultures by February 14th.

As the season advanced perithecial rudiments became more frequent on the stubble, but the proportion of fructifications containing mature asci has remained extremely low, even as late as the month of May.

Perithecia originate below the host epidermis but soon become erumpent, and visible to the naked eye as black granules about 0·5 mm. across, adhering to the surface of the straw (Fig. 9). They may develop at any point, but when only a few occur there is a distinct tendency for them to be clustered at the nodes. Perithecia of *Pyrenophora* may be readily distinguished in the field from all other fructifications found on the stubble, with the exception of *Vermicularia*, by their thick coating of setae, which are clearly discernible when the specimen is held to the light. They are semi-globose when young

(Fig. 8) and about 600 × 700$\mu$ in diameter, but may show indications of an ill-defined ostiolar beak as they approach maturity. The fructifications are covered with stiff, dark brown setae tapering




Figs. 1–4. Ascospores of *Pyrenophora Avenae*. × 250.
Figs. 5, 6. Asci. × 250.
Fig. 7. Setae from perithecium. × 250.
Fig. 8. Immature perithecium from oat stubble. × 60.
Fig. 9. Oat stubble bearing perithecia of *P. Avenae*. Nat. size.

slightly to their rounded ends. Interspersed sometimes with these are dead conidiophores, readily distinguished by their knee-shaped bends. The length of the setae is very variable but commonly as much as 280$\mu$, their thickness being 7–9$\mu$, greatest at the cross-walls (Fig. 7).

Similar bodies, but containing no asci, have been obtained in old

pure cultures of *H. Avenae* on sterilised straw. In agar cultures only sclerotia devoid of setae have been observed.

The asci apparently mature very slowly, and in succession, so that a single fructification may yield all stages from a body 120$\mu$ long with unorganised granular contents, to an apparently mature ascus 280 × 50$\mu$, containing ripe ascospores. They are hyaline, slightly curved structures, with short stipes and rounded apices. The wall is thickened towards the apex and exhibits a well-marked apical pore (Figs. 5 and 6). In the material available the asci contain from 3 to 6, usually 6, yellowish brown ascospores, each exhibiting 3–6 transverse septa, usually 5. One or more of the component cells is usually divided into two by a longitudinal wall, but spores have not been obtained so markedly muriform as those figured by Rathschlag (4). The spores are distinctly constricted at the transverse septa and are surrounded by a hyaline mucilaginous investment, clearly seen when they are mounted in water (Figs. 1–4). Spore dimensions vary according to the number in the ascus but the most normal specimens lie between 49–63 × 21–25$\mu$.

The correspondence of the Scotch specimens with Ito's diagnosis of *Pyrenophora Avenae* is brought out in the following table:

| Ito | Scotch perithecia | Rathschlag |
|---|---|---|
| Perithecia setose | Perithecia setose | No setae |
| Perithecia 450–800 × 350–700$\mu$ | Perithecia up to 800$\mu$ | Perithecia 118–140$\mu$ |
| Asci 250–350 × 35–45$\mu$ | Asci up to 280 × 50$\mu$ | Asci 192 × 29$\mu$ |
| No. of ascospores 2–8 | No. of ascospores 3–6 | No. of ascospores 8 |
| Spores 50·75 × 17·5–30$\mu$ | Spores 49–63 × 21–25$\mu$ | Spores 33 × 14$\mu$ |
| No. of transverse walls 3–6 | Transverse walls 3–6 | Transverse walls 5–8 |
| Longitudinal septa few | Longitudinal septa few | Longitudinal septa many |

The genetic connection of Rathschlag's perithecia with his species of *Helminthosporium* cannot be denied. They were obtained in pure culture and the ascospores were found capable of reproducing the leaf stripe disease in oats. Nor does Rathschlag's description of his strain of *H. Avenae* indicate any divergence from the common type. It appears probable, therefore, that the peculiar features of his *Pleospora Avenae* are best ascribed to its development under artificial and presumably somewhat unfavourable conditions.

## REFERENCES

(1) Dennis, R. W. G. "Studies in the morphology and biology of *Helminthosporium Avenae*." *Trans. Brit. mycol. Soc.* xviii (1933), 223.

(2) Drechsler, C. "Some Graminicolous species of *Helminthosporium*. I." *J. agric. Res.* xxiv (1923), 641.

(3) Ito, S. "On some new ascigerous stages of the species of *Helminthosporium* parasitic on cereals." *Proc. imp. Acad. Tokyo*, vi (1930), 352.

(4) Rathschlag, H. "Studien über *Helminthosporium Avenae*." *Phytopath. Z.* ii, 5 (1930), 469.

# ON VARIATION IN *THAMNIDIUM ELEGANS* LINK, INDUCED BY THE ACTION OF HIGH TEMPERATURES

By B. BARNES

(*Head, Department of Biology, Chelsea Polytechnic, London, S.W.* 3)

(With Plates XIII and XIV and 10 Text-figures)

It has been shown that variant forms of *Eurotium herbariorum* (Wigg.) Link(2), and of *Botrytis cinerea* Pers.(3) can be obtained by heating conidia of these fungi, and then planting the spores on ordinary media. It has also been shown that some of the variant forms persist in culture without any further use of high temperatures, and that there is some relation between the degree of initial change and the degree of constancy of the new forms. It seemed desirable to continue the work with a third fungus, and for this purpose *Thamnidium elegans* was selected. A strain of this species had been in my possession since 1922, and was known to be constant in its behaviour when grown on potato agar. It was known, too, that *T. elegans* was not a common member of the weed flora of the laboratory in the Department of Botany, Birkbeck College (University of London), where the work was done. Since 1922 it had occurred only once in numerous cultures started from rat dung collected in the building, and never developed in cultures inoculated with pigeon dung taken from the roofs and window-sills near the laboratory. Although, during the past twelve years, many plates of various media have been purposely contaminated with dust, *T. elegans* appeared in these cultures only at times when it was known that spores had been recently liberated into the room. If, therefore, the normal form of the species is infrequent in the laboratory, abnormal forms should be still more uncommon. These considerations indicated that there was little danger of experimental cultures being infected with *Thamnidium* from without. Therefore, as a well-tested strain was available, and as the striking morphology of the species offered interesting possibilities of change, experiments were begun in the summer of 1929. Variants were soon obtained, but the preparation of an account of the work has been purposely delayed, in order that the constancy of the variants in culture might be tested over a long period. By the end of 1932, it was clear that reversion to the normal form was far advanced in two variants, while a third and more extreme variant appeared to have settled down into a permanent form distinct from normal.

### Cultural details

Potato agar* has been used as the substratum for all the cultures made in this investigation. The dishes have been incubated for at least three days after pouring, and examined before inoculation to ensure that they were clean at that time; the plates were not opened for this examination, which was made through the lids. The cultures have been kept in the open laboratory, and no attempts have been made to regulate the supply of heat and light. Control cultures, cultures started from heated spores, and routine cultures of the normal and variant forms have been mixed in stacks. Frequent changes in the positions of the stacks, and of the Petri dishes in the stacks, have cancelled out any slight environmental differences. Special precautions have been taken to prevent the entry of mites, by keeping the stacks of cultures on supports surrounded by water(4), by handling the dishes as little as possible, and by placing them when under inspection on glass surfaces freshly cleaned with methylated spirit. Petri dishes taken from the stacks for observation have been wiped with methylated spirit as a preliminary to further handling, so reducing the risk of contamination from dust. Inoculations have been made with cool sterile instruments in a quiet room, the dishes being manipulated on clean sheets of glass, wiped between each inoculation with spirit. These precautions have made it possible to keep the cultures in a satisfactory condition of purity. This communication is based on the examination of over one thousand six hundred cultures, all of which have been kept free from the ordinary "weeds" known to occur in the laboratory. As the usual intruders have been successfully excluded from the cultures, the appearance of the variants cannot reasonably be ascribed to infection from without.

### Experiments with heated spores

In July 1929, single-spore cultures were prepared by a dilution method. Weak suspensions of spores taken from a clean culture of the stock strain of *T. elegans* were made in distilled water, spilled on potato agar, and spread by suitably inclining the dish. After about an hour, the surface of the agar was examined through the lid of the dish, and the positions of well-isolated spores were marked. As soon as growth was visible, ten sporelings were picked out and transferred singly to fresh dishes. The new cultures were examined at intervals of a few hours, and in this way it was established that all the growth present in each dish had arisen from the single sporeling used to start the culture. In due course, mature spores from one of these cultures

* Potatoes, 250 gm.: shred, steam for 1 hour, decant off extract and filter, make up to 1 litre, add 20 per cent. agar, autoclave at 30 lb. pressure for 20 min., and pour hot.

were suspended in distilled water. After thorough agitation, the suspension was poured, in small amounts, into a number of tubes. From one of these, after further shaking, 0·5 c.c. of the suspension was transferred to a dry tube, which was then shaken vigorously in a water bath at a given temperature for a given time. As soon as the time had expired, the suspension was at once spilled on the surface of potato agar in a dish, and spread by inclining the dish. Further lots of spores were similarly treated, each lot being taken from a fresh sample of suspension. Control cultures were prepared, at the same time, from unheated lots of suspension. In these operations, as in all the experiments with heated spores, the distilled water, media and glass ware were carefully sterilised before use.

The cultures were examined at intervals of a few hours during the

Table I. *Experiments with heated spores of* Thamnidium elegans, *25. vii. 29*

| Temp. °C. | Time min. | No. of cultures | Notes |
|---|---|---|---|
| 45 | 2 | 2 | Growth normal, 12–20 colonies in each |
| 50 | 2 | 2 | One culture normal; one with slight retardation in early growth, then normal |
| 55 | 2 | 2 | One culture normal. The other (culture 55.2) contained 14 normal colonies and two light-coloured colonies of weak growth; these yielded variants |
| 60 | 2 | 2 | No growth |
| 65 | 2 | 2 | No growth |
| 70 | 2 | 1 | Eight normal colonies and one light-coloured variant with large heads of sporangiola. This yielded a variant |
| 75 | 2 | 1 | No growth |
| 80–100 | 2 | 5 | No growth |

Ten controls, all normal, each with 15–20 colonies.

Table II. *Experiments with heated spores of* Thamnidium elegans, *1. viii. 29*

| Temp. °C. | Time min. | No. of cultures | Notes |
|---|---|---|---|
| 45 | 1 | 2 | Growth normal } |
| 45 | 2 | 2 | ,, |
| 45 | 3 | 2 | ,, } 15–23 colonies |
| 50 | 1 | 2 | ,, |
| 50 | 2 | 2 | ,, } |
| 50 | 3 | 2 | Early growth slightly retarded; normal later |
| 60 | 1 | 2 | Retardation in early growth. Two colonies, light in colour, and with large heads of sporangiola; not taken into culture |
| 60 | 2 | 2 | No growth in one. In the other, a single colony, light in colour, and of slightly retarded growth; a subnormal form, not taken into culture |
| 60 | 3 | 2 | No growth in one. In the other, a weak, sterile mycelium which soon died |
| 70–100 | 1–3 | 24 | No growth |

Ten controls, all normal, with 17–22 colonies.

first two days after preparation, special attention being paid to the rate at which the spores germinated, and to the appearance of the young colonies. The results of the first two sets of experiments are given in Tables I and II.

From the cultures listed in Table I, two well-marked variants, and a third of less obvious character, were isolated. From these isolations, long series of cultures were started. Attempts were made to propagate the weak sterile mycelium noted in Table II. This mycelium was certainly phycomycetous, and presumably belonged to *Thamnidium*. It reached a diameter of 0·8 cm. in the original culture, then ceased to grow, and died out. The growth was weak and deformed, remaining quite sterile. Six hyphal transfers were made to fresh potato agar, but they all failed to establish themselves. This weak form may be compared with the variants of reduced vitality found in *Botrytis cinerea* ((3), p. 840).

During 1930 and 1931, additional experiments were made with heated spores, using the methods already described; 314 cultures were started from heated spores, and 102 control cultures, from unheated spores, accompanied them. The results of these experiments showed general agreement with those given in Tables I and II. Cultures from unheated spores never produced any abnormal colonies; cultures from heated spores gave variants in about the same proportions, and in the same erratic fashion as the cultures of the earlier experiments. None of these variants was noticeably distinct from variants already in culture and none was taken into prolonged culture. Spores exposed to temperatures below 50° C. never gave a variant. After treatment at 50° C. there were usually signs of retardation of early growth, though the mature colonies appeared to be normal. Spores treated between 55 and 70° C. gave some colonies apparently normal, and others with large or with small heads of sporangiola, and light in colour. With increasing temperature there was decrease in the number of germinations; growth was never obtained from spores which had been heated to temperatures exceeding 70° C.

### Isolation of the variants obtained in 1929

Spores taken from the abnormal colonies noted in Table I were suspended in quantities of 0·5 c.c. distilled water, and spread on potato agar in the manner already described: the suspensions were not heated. Control cultures from normal spores were prepared at the same time. Next day, examination showed that the cultures started from the abnormal colonies in the original experimental dishes contained sporelings readily distinguishable from normal sporelings by their small size and irregular branching; at this time it was easy to see that the sporelings had developed from single spores. Small,

irregular sporelings were of general occurrence in the progeny of the abnormal colonies; none developed from spores taken from normal colonies. The characteristic peculiarities of the variants were shown equally by sporelings growing close together, and sporelings well separated on the medium; therefore they were not due merely to the effects of competition. On the second day after the preparation of these cultures, some of the more irregular of the abnormal sporelings were transferred separately to fresh dishes. From these transfers, three distinct variants were ultimately isolated: they will be referred to as the large-headed variant, the dwarf variant and the subnormal variant.

Series of cultures, made up of successive sets—a set being the lot of cultures made up on a given date—have been grown of the variants and of the normal form. The cultures, for the most part, have been started by transfers of spores with a cool platinum wire; only occasionally have single spore isolations been made. The mass transfers of spores eliminate the possibility that the maintenance of the variants in culture has been due to the continued selection of specially abnormal material. Sets of cultures of all the variants have not always been made on the same day, but normal cultures have always been started whenever variants have been transferred; consequently the number of sets of normal cultures shown in Table III is in excess of the number of sets of any one of the variants.

Table III. *Summary of cultures of* Thamnidium elegans, *normal and variant, on which this account is based*

| Type | Series | Number of sets in series | Number of cultures in series | Period during which the series was under observation |
|---|---|---|---|---|
| Normal form | C | 73 | 234* | August 1929–December 1932 |
| Dwarf | DA | 68 | 187 | August 1929–December 1932 |
| Dwarf | DF | 25 | 71 | August 1929–July 1930 |
| Dwarf | DH | 21 | 38 | August 1929–May 1930 |
| Subnormal | DJ | 10 | 17 | August 1929–March 1930 |
| Subnormal | DK | 58 | 136 | August 1929–December 1932 |
| Large-headed | M | 62 | 170 | October 1929–December 1932 |
| Large-headed | P | 67 | 172 | August 1929–December 1932 |
| Large-headed | Z | 32 | 79 | August 1929–October 1930 |

* This number does not include the control cultures used for comparison with cultures started from heated spores.

## *Thamnidium elegans* and its variants

### (*a*) *Normal* Thamnidium elegans. (Pl. XIII, figs. 2 and 5; Pl. XIV, figs. 9 and 12)

In the normal form of *T. elegans*, fertile axes arise in large numbers from the prostrate vegetative mycelium, and commonly terminate in large sporangia, which, like those of *Mucor*, contain each a columella

and many spores. In addition, dichotomising branch systems develop on the sporangiophores in superposed lateral tufts, and bear small sporangia—the sporangiola—at the ends of their ultimate ramifications. A sporangiolum does not possess a columella, and contains but few spores; these differ in no known way from the spores formed in the large sporangia. A brown pigment is present in the walls of the spores, other parts of the fungus being colourless, or but slightly coloured.

*Development in culture of normal* T. elegans. Spores of the stock strain germinate in a few hours after they are placed on potato agar; twelve hours after planting, the germ tubes have a length of four to six spore diameters, and have begun to branch. A colony a day old is easily visible to the naked eye (Text-fig. 1 *a*). Young colonies are rather loose in growth, and, for the first two or three days, main hyphae running radially outwards from the position occupied by the spore are readily distinguished; owing to swelling, the spore is seldom recognisable as such, a few hours after germination has occurred. The main hyphae spread radially and evenly on the medium (Text-fig. 2 *a*). Lateral hyphae develop from them at fairly regular intervals, and, as the main hyphae diverge, some of the laterals elongate rapidly in the free space and begin to function as main hyphae. Some hyphae penetrate the medium, but in early stages of growth they are few. Aerial branches seldom become strong until the colony is about two days old, and has formed a fairly dense edge, lying on the medium; they develop first in a central tuft of small heads of sporangiola on short stalks, large *Mucor*-like sporangia not yet being abundant. During the next two or three days, long sporangiophores ending in large sporangia arise in large numbers from the centre of the colony, the tuft becoming a conspicuous feature of the culture. Lateral tufts of sporangiola form abundantly on the sporangiophores, and, beneath this tall growth, which if space permits may attain a height of several centimetres, small terminal heads of sporangiola on short hyphae continue to form in limited numbers. By the fifth or sixth day, although sporangiophores are developing freely, they no longer make dense masses, and the aspect of the culture is now largely determined by the tufts of sporangiola, which increase in number and size. As the growing edge of the colony approaches the edge of the medium, the hyphae composing it begin to branch in an irregular manner, long sporangiophores with lateral tufts of sporangiola cease to grow abundantly, and short hyphae ending in terminal heads of sporangiola again become prominent. Throughout the life of the colony, large sporangia on short sporangiophores without lateral sporangiolic tufts develop in small numbers, but they are never abundant.

The lateral groups of sporangiola are dense, as the dichotomous branch systems composing them fork frequently, and consist of relatively short members. Large heads may exceed 0·5 mm. in dia-

meter, and some exceed 1 mm. in diameter. The average diameter of five hundred heads measured at random was 0·3 mm.

The normal form of *T. elegans* covers a surface of potato agar, 9 cm. in diameter, in from eight to nine days. By this time the centre of the colony is brownish (Ridgway, 17‴, *i* to *k*), but the edge, where unripe sporangiola abound, is white. The whole culture is uniformly brown by the fourteenth or the fifteenth day.

More than three hundred cultures of the normal form have been closely examined at all stages of their growth. None of these cultures showed any noteworthy divergence from the general behaviour just described, and in no culture was anything resembling the variants seen. The cultures confirmed the impression gained between 1922 and 1929, that the stock form of *T. elegans* is very steady in behaviour in ordinary culture.

From time to time, sets of cultures of the normal form have been made from parent cultures of diverse ages. Spores have been taken from cultures only three days old, and from old, dry cultures ninety days old; between these extremes, many intermediate ages were tested. Evidence was not obtained that, within these limits, the age of the spores had any influence on the characters of the colonies they yielded. Cultures started from hyphae grew like cultures started from spores.

### (*b*) *Variant forms of* Thamnidium elegans

When the three variants were first isolated in 1929, they differed from the normal form in rate of growth, colour, and in the average dimensions of the heads of sporangiola. These characters were sufficiently obvious to allow of the examination of the cultures without opening the dishes, a very necessary condition when contamination had to be avoided.

(1) *The large-headed variant* (*Table III, Series M, P, Z*). (Pl. XIII, figs. 1, 4, 6 and Pl. XIV, figs. 8, 11.)

The large-headed variant was isolated from a colony of loose growth and light colour, obtained from a lot of spores heated to 70° C. for two minutes (Table I). Three isolations were made by the dilution method, when the original colony was twenty, twenty-five and sixty days old respectively. All the sporelings from these isolations were distinct in character from normal sporelings, and, as all appeared to be of the same kind, one only was taken from each isolation for further investigation: the three sporelings selected were the starting points of Series M, P and Z (Table III).

The variant came out clean from the first, and has behaved in the same way in the three series; it is the most extreme of the variants described in this communication, and, up to the time of writing,

has shown no marked indications of reversion to the normal condition.

*Development in culture of the large-headed variant.* Spores of the large-headed variant germinate fairly rapidly; germ tubes are present in twelve to eighteen hours after planting. Young colonies about a day old (Text-fig. 1 *c*) have a weak, stunted appearance, and consist of little more than a few main hyphae. As the colony develops, it becomes surrounded by a spreading prostrate edge, but in this, the main hyphae (Text-fig. 2 *b*) branch less freely than those of normal *T. elegans*, and do not give the regular pattern characteristic of the ordinary strain.

Aerial hyphae begin to form in large numbers when the cultures are three or four days old. The first to form may remain sterile, but most ultimately bear heads of sporangiola. The aerial hyphae of the large-headed variant react much more strongly to light than do the aerial hyphae of the stock strain; in one-sided illumination, positive phototropic response may be so strong that the hyphae lie nearly horizontally. There are rarely straight or evenly curved, for they are commonly formed like a loose and much elongated corkscrew (Text-fig. 6 *b*).

A culture of the large-headed variant four days old possesses a central tuft of sporangiolic heads, with some terminal sporangia. As growth proceeds, this tuft spreads outwards, but, as in normal cultures, seldom extends to the margin of the medium. Terminal sporangia form in fair numbers, some on the ends of long sporangiophores, some on short sporangiophores without lateral tufts. Small heads of sporangiola are also produced, but they are not abundant. When the cultures are eight to ten days old, the central area is light brownish (Ridgway, XL, 21‴, *f*) and this colour spreads to the periphery as the sporangiola mature. It is, however, soon hidden by a rich development of sterile hyphae, hiding the mature sporangiola and often rendering the culture snow-white. The white condition is reached in from fourteen to twenty-one days, so that old cultures of the variant differ noticeably from normal cultures of the same age (Pl. XIII, figs. 4 and 5).

The sporangiolic tufts of the large-headed variant are considerably larger than normal heads; they frequently exceed 1 mm. in diameter. The average diameter of five hundred heads was 0·54 mm.

The early cultures of the variant grew about half as fast as did normal cultures: the growth rate has since increased, and appears to have settled down at about three-quarters the normal value.

(2) *The dwarf variant* (Pl. XIII, figs. 3 and 7; Pl. XIV, figs. 10 and 13).

The dwarf variant was obtained from one of the light-coloured colonies in Culture 55.2, Table I. Preliminary transfers from this

colony gave sporelings of stunted and irregular appearance (Text-fig. 1 *b*); one of these was transferred to a fresh dish. The resulting colony developed in a peculiar manner. Growth was slow and weak, the colony being only 1·4 cm. in diameter when the corresponding control colonies had covered a surface 9 cm. in diameter. At that time, nine days after transfer, the mycelium bore a few small, whitish heads of sporangiola, scattered irregularly over the surface on short stalks; long sporangiophores and large sporangia were absent. After fourteen days, the colony was 4·5 cm. in diameter. Heads of sporangiola were still few, and large sporangia were not present. On the fourteenth day, a central tuft of long aerial hyphae began to form; they were all sterile, and, like those of the large-headed variant, they reacted strongly to light, and were loosely spiral in shape. Next day weak signs of sectoring were noted, and, when the colony was three weeks old, it consisted of two distinct areas, one bearing aborted sporangiophores, and no good fructifications, the other thinly covered by small heads of sporangiola on short erect hyphae.

Isolations were made from both areas. Spores from the sporangiola gave clean cultures of the dwarf variant (Series DA, Table III). Hyphal transfers from the edge of the other region also yielded cultures of the same type (Series DH, Table III).

Subsequently, further isolations were made from the original variant colony in Culture 55.2, Table I. These yielded clean cultures of the dwarf variant (Series DF, Table III). Series DF and DH were continued for about a year, and then discontinued, as the cultures composing these series agreed in all respects with the cultures of Series DA.

The peculiar behaviour of the colony which sectored was not repeated in any of the cultures derived from it, so that the initial instability indicated by the sectoring soon disappeared from the strain. Instability in colonies grown from heated spores, or in the offspring of such colonies, was noted in *Eurotium herbariorum*(2), and in *Botrytis cinerea*(3); in the latter it persisted through a number of cultures.

*Development in culture of the dwarf variant.* In the earlier cultures of the dwarf variant, the spores germinated more slowly than normal spores, and, usually, germ tubes were not visible twelve hours after the spores were sown. Small colonies developed within twenty-four hours; these colonies had an average diameter one-quarter that of normal colonies of the same age, and they had a characteristic aspect owing to the development of many short lateral branches. The colonies continued to grow about half as fast as the controls. The growth was low and thin, and, in the spreading edge of the mycelium, the main hyphae pursued a curved course, and bore their lateral branches unevenly, showing but a faint suggestion of the even pattern usual in normal mycelia of *T. elegans*. Many hyphae grew into the medium.

At least fourteen days were required for the colony to cover a surface 9 cm. in diameter. Mature colonies differed greatly in appearance from mature controls. Dense tufted growth was absent, even from the centres of the colonies, large sporangia on long sporangiophores were scantily present, and the sporangiolic heads, at the ends of remarkably short stalks, were thinly scattered about the culture. The heads of sporangiola were small; it was rare to observe one which exceeded 0·5 mm. in diameter. The average diameter of five hundred heads was 0·16 mm. Old cultures were light brown (Ridgway, XL, 17″, *b* to –).

As in the large-headed variant, the growth rate increased during the first few months of culture, but did not attain normality. The morphological peculiarities were retained almost unchanged for over a year, though, as time went on, there was a gradual increase in general strength, which, unfortunately, cannot be expressed in any definite manner. By the end of 1931, when the dwarf variant had been in culture for over two years, and had passed through 55 transfers, it was still distinct from the normal strain; in particular, the production of stunted sporelings was a feature of the variant. During 1932, reversion to normal became more pronounced, and, by the end of that year, mature cultures of Series DA were not greatly different from normal cultures, though a slight weakness in growth was still demonstrable.

(3) *The subnormal variant.*

The subnormal variant was isolated from the second light-coloured colony in Culture 55.2, Table I. The first isolations gave colonies clearly distinct from normal colonies; from these two series (Series DJ and DK, Table III) were started. Series DJ was discontinued when it was obvious that the cultures were alike in Series DJ and DK.

The subnormal variant did not differ much from normal except in one respect. In the early cultures of Series DJ and DK, rich crops of large sporangia, carried on short sporangiophores without lateral tufts of sporangiola, developed in the growing edges of the colonies. It was suspected that the cultures were contaminated by a small species of *Mucor*, but single spores taken from the sporangia reproduced the variant, and removed all doubts. In strength of growth, sporeling characters, manner of branching of the hyphae in the spreading edge of a colony, in colour, and in the extent to which small heads of sporangiola developed, the subnormal variant was intermediate between the normal and the dwarf forms.

It was evident by October 1929, when this variant had passed through eight transfers, that the production of many sporangia on short stalks was falling off, but the cultures were still somewhat thinner and weaker in general growth than normal cultures. By the

summer of 1931, when thirty-seven transfers had been made, it was hardly possible to distinguish cultures of the subnormal variant from ordinary cultures, but, as will be shown presently (p. 310), it is possible that complete reversion had not occurred, for the variant retained a tendency to develop more spores in the sporangiola than did the normal *T. elegans*.

Table IV summarises the notes made on a set of cultures three days old, started by single colony transfers in May 1931, nearly two years after the variants were induced. The information gives some measure of the differences existing between the four forms at that time.

Table IV. Thamnidium elegans, *normal and variant (three cultures of each type)*

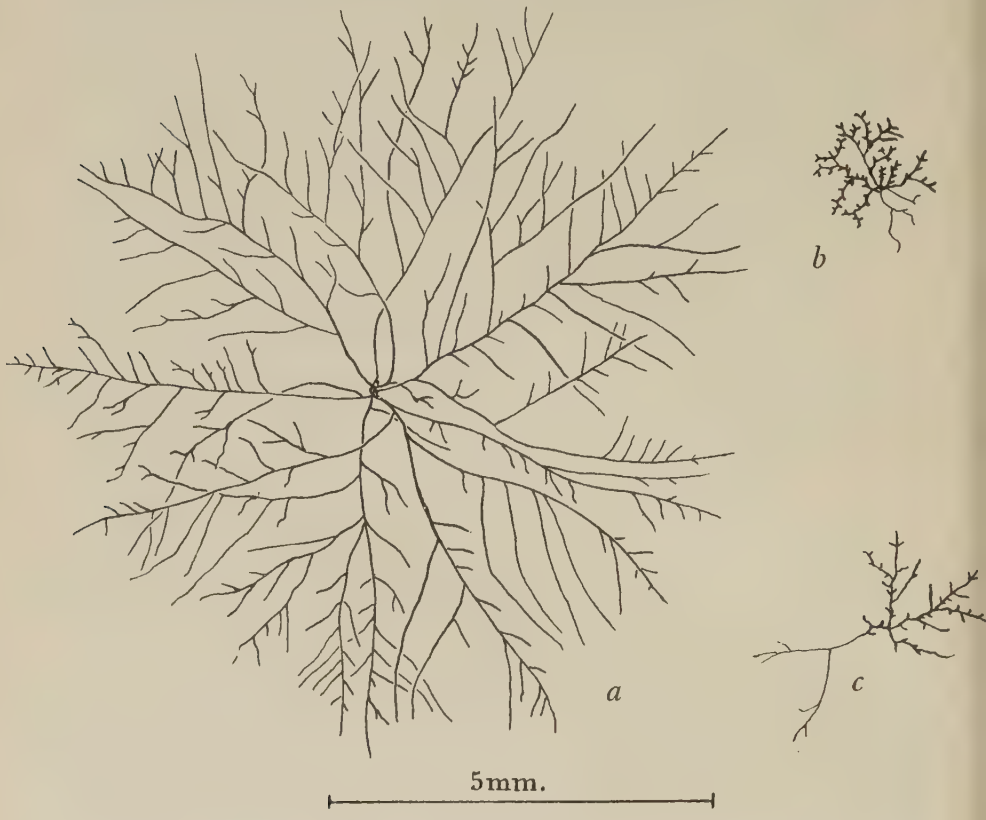
| Series | Diameter, mm. Whole colony | Diameter, mm. Fertile area | Remarks |
|---|---|---|---|
| C (normal) | 22 | 12 | *Edge*. Outline even, hyphae abundant, showing the usual regular branching |
| | 23 | 12 | |
| | 23 | 11 | *Centre*. Dense group of small head of sporangiola |
| M (large head) | 18 | 4 | *Edge*. Outline slightly uneven, hyphae looser than in C; branching showing vague pattern only |
| | 17 | 3 | |
| | 18 | 3 | *Centre*. Some sterile hyphae, strongly phototrophic. Heads beginning to form |
| DA | 19 | 3 | *Edge*. Outline even, hyphae rather crowded, no regular branching |
| | 17 | 4 | *Centre*. Low dense tuft with a few small heads |
| DK (subnormal) | 21 | 9 | *Edge*. Outline even, branching nearly as regular as controls |
| | 23 | 10 | |
| | 22 | 9 | *Centre*. Dense group of small heads, as in C. A few large sporangia only |

### (*c*) *Details of morphology and sporulation*

When the three variants were first isolated, they all grew more slowly than the parent form, and, to a greater or less extent, were distinguished by their lighter colour. They differed from normal *T. elegans*, and from one another, in the dimensions of the heads of sporangiola, and in the proportions in which sporangia and sporangiola were produced. It has been necessary in describing the behaviour of the forms in culture to make some reference to morphological features; these features will now be described in more detail. The drawings and photographs of *T. elegans* and of its variants which appear in this communication were taken from average examples of the objects they represent; they were not taken from specimens chosen to emphasise the differences between the normal and the variant forms.

(1) *The young colony*. Sporelings about twenty-four hours old are at a favourable stage for examination. Three sporelings of this age are

represented in Text-fig. 1; the normal sporeling shows already indications of the regular manner of branching characteristic of normal *T. elegans*; the spreading growth of this sporeling contrasts well with the stunted growth of the variant sporelings. The drawings were made when the variants had been in culture for two years and three months; the dwarf variant had retained the peculiar features of its sporelings



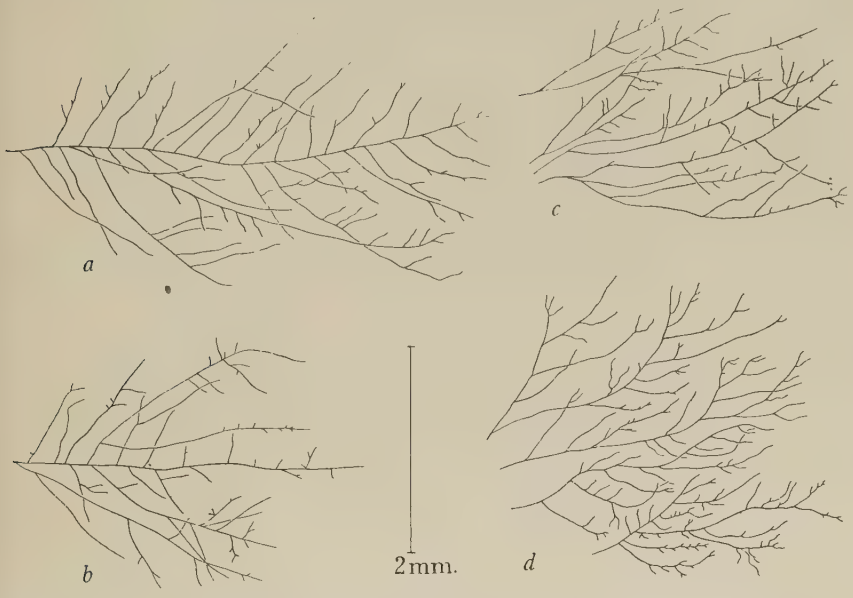

Text-fig. 1. *Thamnidium elegans*. Mycelia, 24 hours old, from single spores germinated on potato agar in dishes poured from the same lot of medium. *a*, normal form. *b*, the dwarf variant. *c*, the large-headed variant.

through fifty-four successive transfers, and the large-headed variant had done so through forty-eight transfers.

(2) *Branching in the growing edge of the colony.* The main hyphae of the normal strain spread evenly over the medium and branch in a regular fashion; the contrast between this regularity and the greater or less irregularity of the variants appears clearly in the photographs (Pl. XIV, figs. 8–10) and drawings (Text-fig. 2); a verbal description is

unnecessary. These hyphal characters are best investigated in cultures four to five days old, for, as the mycelium approaches the edge of the mycelium, branching becomes irregular, even in the ordinary form.

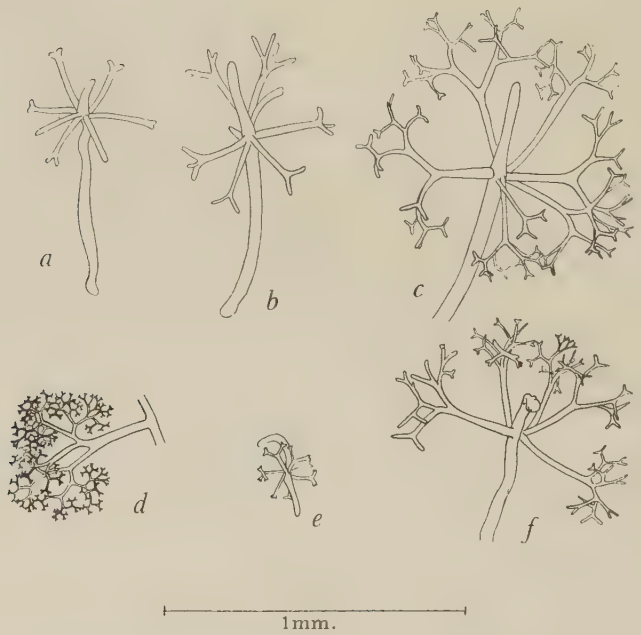
(3) *The fructifications.* The distinct aspects of cultures of normal *T. elegans* and of its variants were largely due to the differences in the diameters of the sporangiolic heads, due chiefly to the lengths reached by the successive branches of the dichotomising systems before they forked.




Text-fig. 2. *Thamnidium elegans.* Marginal hyphae from sister-cultures. *a*, normal form. *b*, the large-headed variant. *c*, *d*, the dwarf variant.

Almost all the heads of sporangiola in the dwarf variant (Text-fig. 3) were formed on short erect hyphae often less than a millimetre long. Very commonly, a whorl of four lateral branches arose a little below the tip of the hypha, these branches then forking several times and bearing the sporangiola on the tips of their ultimate ramifications. The tip of the main hypha did not always behave in the same way. Sometimes it persisted in a turgid and apparently healthy condition until the sporangiola contained ripe spores, but did not elongate. Sometimes the tip forked, each of the branches then forking two or three times, and eventually producing sporangiola. In other specimens, the tip grew on to form a tapering prolongation, from whose sides fertile branch systems or abortive attempts at fertile branch systems, might develop. Very frequently, the tip of the main axis

Text-fig. 3. *Thamnidium elegans*. Fertile heads of the dwarf variant. *a–e*, young stages. *f–h*, stages just before the development of sporangiola.




Text-fig. 4. *Thamnidium elegans*. Fertile heads of the normal form. *a–c*, young stages. *d*, one branch of a fertile head, just before the formation of sporangiola. *e*, young stage of a weak head, of the kind produced in very young cultures and towards the end of the period of growth. *f*, a head in course of formation, with the tip of the main hypha collapsing.

degenerated and either collapsed or persisted as a tiny papilla crowning a slight swelling of the axis. Rarely, the tip grew on, the lengthening hypha bore one or more successive sporangiolic tufts, and a large sporangium was organised at the end of the main fertile axis. Most of the fructifications of the dwarf variant had a stunted and partially abortive appearance.

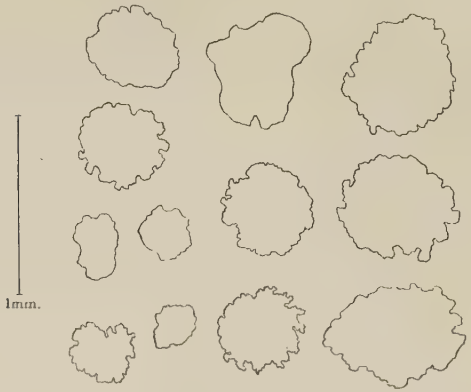
In cultures of the stock strain (Text-fig. 4 *e*), small terminal heads of sporangia developed, which in general characters were like the small heads usual in the dwarf variant. These heads however were

Text-fig. 5. *Thamnidium elegans*. Fertile heads of the large-headed variant. *a–d*, young stages. *e*, one branch of a fertile head, just before the formation of sporangiola, for comparison with Text-fig. 4*d*.

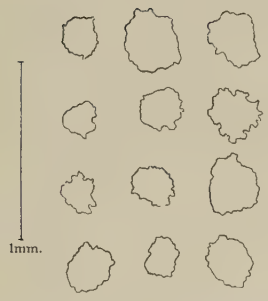
usually built up around at least five lateral branch systems, and they had a more robust appearance than those of the dwarf variant.

The sporangiolic heads (Pl. XIII, fig. 6, and Text-figs. 5 and 6) of the large-headed variant owed their size to the length of their constituent branches rather than to more extensive dichotomy. They probably bore no more sporangiola than average heads of the normal form, but were looser in construction. The main fertile axes of the large-headed variant usually reached as great a length as those of normal *T. elegans*, and often ended in a large sporangium. In this variant, especially when the mycelium was approaching the edge of the medium, large sporangia formed in fair numbers on the ends of short, simple sporangiophores, and, at the same time, as in the

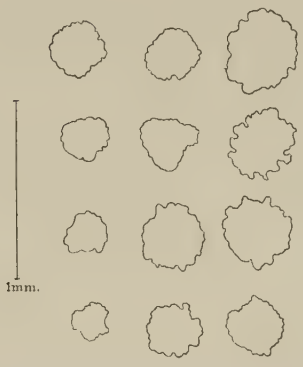
Text-fig. 6. *Thamnidium elegans*. The large-headed variant. *a–b*, weak aerial hyphae, usually strongly positively phototropic, and often remaining sterile. *c–e*, the sterile aerial branch systems characteristic of old cultures of the large-headed variant. *f*, a small fertile head, for comparison with Text-fig. 4*e*.



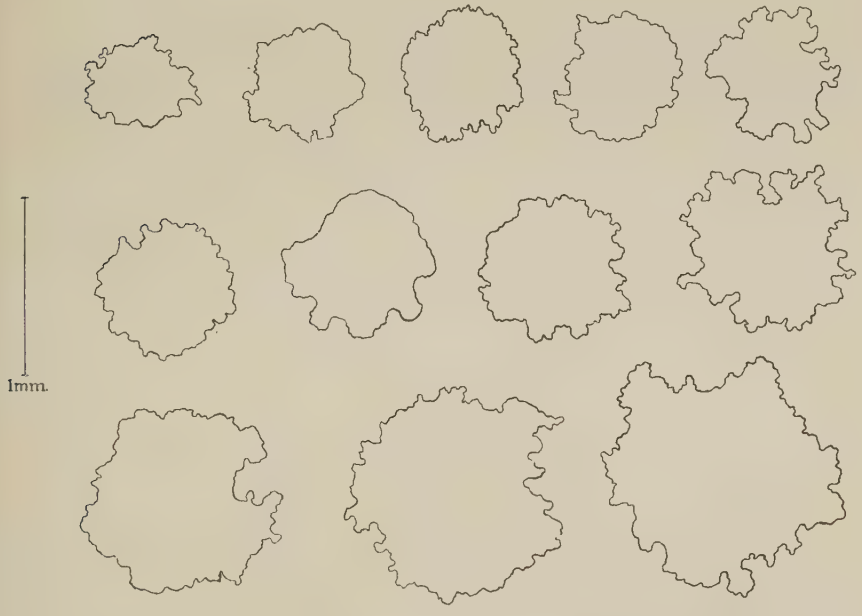

Text-fig. 7. *Thamnidium elegans*. Outlines of twelve heads of the normal form, chosen at random.




Text-fig. 8. *Thamnidium elegans*. Outlines of twelve heads of the dwarf variant, chosen at random.




Text-fig. 9. *Thamnidium elegans*. Outlines of twelve heads of the subnormal variant, chosen at random.




Text-fig. 10. *Thamnidium elegans*. Outlines of twelve heads of the large-headed variant, chosen at random.

ordinary form, heads of sporangiola were organised at the ends of short hypha (Text-fig. 6*f*): these heads showed the same looseness of construction as the lateral heads. In cultures of the large-headed variant about a fortnight old, a strong tendency became apparent for many of the branches in a sporangiolic tuft to fail to fructify, but to elongate and sometimes to bear lateral tufts of forking sterile branches in their turn (Text-fig. 6 *d*, *e*). In old cultures, most samples taken for inspection contained all possible transitions from sporangiolic heads with every ultimate branchlet ending in a sporangiolum, to tufts of hyphae, evidently built up on a dichotomising system, but with only three or four dichotomies, and completely sterile.

Camera lucida tracings of the outlines of twelve heads of sporangiola from each of the four forms of *T. elegans* appear in Text-figs. 7–10. The twelve heads represented were chosen at random, the drawings being made from untouched living material in an unopened dish.

Although many samples were examined and measured, it was not possible to demonstrate any constant difference in form or in dimensions between the spores of normal *T. elegans* and of its variants.

### The number of spores in the sporangiola

From time to time, counts have been made of the number of spores in the sporangiola of the various forms. In order to get fair sampling, the following method was used. Ripe tufts of sporangiola were mounted in water, and the slide was moved by means of the

Table V. *Spore contents of sporangiola of* Thamnidium elegans

| Form of *T. elegans* | Normal | Subnormal | Dwarf | Large head |
|---|---|---|---|---|
| No. of sporangiola examined... ... | 3500 | 3500 | 3500 | 9000 |
| Percentage of sporangiola with spore content of | | | | |
| 0 | — | — | — | 0·32 |
| 1 | 2·51 | 0·43 | 4·80 | 12·87 |
| 2 | 30·77 | 11·00 | 25·71 | *47·90* |
| 3 | *51·74* | *32·06* | *46·57* | 30·08 |
| 4 | 12·66 | 27·80 | 17·51 | 6·58 |
| 5 | 1·88 | 14·08 | 4·06 | 1·46 |
| 6 | 0·34 | 8·08 | 0·83 | 0·49 |
| 7 | 0·08 | 4·31 | 0·31 | 0·19 |
| 8 | — | 1·14 | 0·11 | 0·05 |
| 9 | — | 0·66 | 0·08 | 0·02 |
| 10 | — | 0·17 | — | 0·01 |
| 11 | — | 0·08 | — | — |
| 12 | — | 0·11 | — | — |
| 13 | — | 0·02 | — | — |
| 14 | — | — | — | — |
| 15 | — | — | — | — |
| 16 | — | 0·02 | — | — |

mechanical stage so that a number of separate strips of the preparation were examined. The spores lying in the uninjured sporangia which crossed an eyepiece scale between graduations 4 and 6 were counted. Counts were made from detached sporangiola, and from sporangiola still attached to their hyphae. On each occasion, the contents of five hundred sporangiola of each form of *Thamnidium elegans* were counted, the material being taken from cultures of the same set, generally about a fortnight old. The results of these counts, expressed in the form of percentages, are given in Table V.

The four forms of *Thamnidium elegans* evidently fall into two groups, one, including normal, subnormal and dwarf, with three-spored sporangiola predominating, the other including the large-headed variant only, with two-spored sporangiola predominating. In the three-spored group, the normal form alone is a constant one, for the two variants have gradually reverted towards it. The large-headed variant has remained consistently abnormal, retaining its light colour and its peculiarities of behaviour and morphology. The three-spored condition in normal *T. elegans* does not agree altogether with the statements in the literature that the sporangiola of *T. elegans* most often contain four spores. The stock strain used in this work may possibly be abnormal in its tendency to produce less than four spores in most of its sporangiola. As however Corda(6), van Tieghem and Le Monnier(14), Fischer(10) and other authors who have described *T. elegans* do not indicate the number of counts on which their statements are based, the possible abnormality in the stock strain is not regarded as established. Even if that abnormality exists, there is no doubt that the stock strain is of great constancy. The evidence of constancy afforded by behaviour during a long period of culture, and by frequent examinations of the morphological features of the strain, is strongly supported by the results of counts of the number of spores in the sporangiola. These counts are set out in detail in Table VI; they show that no significant alteration has occurred during the period 1929–33.

Table VI. *Spore contents of sporangiola of normal* Thamnidium elegans

| No. of sporangiola with spore content of | Date of observation: 1. x. 29 | 31. x. 29 | 22. ix. 30 | 2. xii. 30 | 16. ii. 31 | 20. i. 32 | 24. ii. 33 | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 13 | 14 | 33 | 12 | 3 | 10 | 3 | 88 |
| 2 | 176 | 169 | 170 | 176 | 109 | 153 | 124 | 1077 |
| 3 | 218 | 277 | 257 | 262 | 255 | 268 | 274 | 1811 |
| 4 | 81 | 33 | 35 | 44 | 104 | 63 | 83 | 443 |
| 5 | 9 | 7 | 4 | 6 | 22 | 3 | 15 | 66 |
| 6 | 2 | — | 1 | — | 5 | 3 | 1 | 12 |
| 7 | 1 | — | — | — | 2 | — | — | 3 |

Table VII. *Spore contents of sporangiola of the subnormal variant of* Thamnidium elegans

| No. of sporangiola with spore content of | Date of observation: 1. x. 29 | 31. x. 29 | 22. ix. 30 | 2. xii. 30 | 16. ii. 31 | 20. i. 32 | 24. ii. 33 | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | — | 2 | — | — | 9 | 15 |
| 2 | 17 | 30 | 7 | 53 | 43 | 107 | 128 | 385 |
| 3 | 60 | 108 | 102 | 157 | 192 | 302 | 201 | 1122 |
| 4 | 98 | 156 | 178 | 178 | 159 | 82 | 122 | 973 |
| 5 | 104 | 100 | 113 | 75 | 69 | 7 | 25 | 493 |
| 6 | 102 | 54 | 62 | 25 | 28 | 1 | 11 | 283 |
| 7 | 70 | 34 | 30 | 6 | 6 | 1 | 4 | 151 |
| 8 | 22 | 9 | 6 | 2 | 1 | — | — | 40 |
| 9 | 15 | 3 | 2 | 2 | 1 | — | — | 23 |
| 10 | 4 | 2 | — | — | — | — | — | 6 |
| 11 | 1 | 1 | — | — | 1 | — | — | 3 |
| 12 | 3 | 1 | — | — | — | — | — | 4 |
| 13 | 1 | — | — | — | — | — | — | 1 |
| 14 | — | — | — | — | — | — | — | — |
| 15 | — | — | — | — | — | — | — | — |
| 16 | 1 | — | — | — | — | — | — | 1 |

The details of the counts made of the number of spores in the sporangiola of the subnormal variant contrast in an interesting manner with the counts relating to the normal form; they appear in Table VII. The drift towards normality shown by the subnormal form in culture is equally apparent in the production of spores in the sporangiola of successive cultures. It will be remembered that, when first recognised, the subnormal variant was specially characterised by the abundant development of large sporangia on short sporangiophores; this peculiarity in the constitution of the subnormal variant undoubtedly influenced the numbers in which spores developed in the sporangiola. In the early cultures, as a comparison of Tables VI and VII shows, there were great differences in this respect between the normal and subnormal forms. The divergence became less in later cultures, but, even at the beginning of 1933, over three years after the subnormal variant was taken into culture, the agreement in the counts of spores contained in the sporangiola of the normal and subnormal forms was not, perhaps, quite close enough to justify a conclusion that the subnormal variant had completely reverted to normal.

*Characters of the large sporangia*

The large sporangia appear to be alike in the normal form and in the variants. Measurements of the diameters of 1500 large sporangia taken from a number of cultures at intervals during the period of the investigation, revealed no significant differences in this character. Morphological variations were not noted.

## Concluding remarks

The results of the experiments with *T. elegans* confirm those previously obtained with *Eurotium herbariorum* and *Botrytis cinerea*. Variants appear in cultures from heated spores in numbers large enough to be significant, though, when the results of experiments with heated spores are compared with those of experiments in which X-rays have been used to provoke change (8, 9, 11), it is evident that, as a means of causing variation, the use of high temperatures is comparatively unproductive. Probably the point at which change occurs is close to the thermal death point.

It is not proposed to survey here the large volume of published work that now exists on induced variation. A number of investigators have successfully induced more or less permanent variations in both animals and plants, by the use of X-rays, ultra-violet light, radium, chemicals and relatively high temperatures. The results of experiments of this kind cannot be dismissed as due to faulty technique or to the selection of abnormalities already present in the stock. The variants of *T. elegans* were certainly not obtained by mere selection. If the normal stock was liable to vary, variants should have appeared sometimes in the large number of control cultures made during the investigation; they could never be found in control cultures, young or old. The spores of the established variants germinate without difficulty and without special treatment, and without a lag sufficient to allow the normal form to overgrow the variant sporelings; consequently there is no reason to suppose that the germination of the abnormal spores is favoured by a preliminary exposure to high temperatures. Direct experiment shows that normals and variants will grow side by side when planted in the same dish, each preserving its characters and remaining recognisable in dry cultures months or years old.

The variants are best regarded as weakened versions of normal *T. elegans*, damaged by the preliminary heating. In two, the damage appears to have been such that it could be slowly repaired during a long period of culture; these variants have been able to make a close approach to the normal state, if not to resume it completely. Temporary variants of this kind, even if able to persist for a long time in culture, cannot be regarded as possible sources of new species or varieties, though, were they found wild, they would probably be described as such.

The third variant has remained distinct, and may be a permanent form. This, the large-headed variant, is distinguished by its tendency to develop sporangiola with a small spore content, and to bear sterile branches in the sporangiolic heads. These characters, in a more pronounced form, are among the characters which separate *Thamnidium*

and *Chaetocladium*, so that, in these respects, we have an interesting parallel between the sort of changes that may occur under conditions of experiment, and the changes that may have occurred during the evolution of the Mucorales.

Savulescu and Rayss (13) have shown that spores of *Nigrospora Oryzae* may give rise after treatment at high temperatures to stunted progeny, but these investigators did not determine if the changed characters were transmitted to subsequent cultures. Their observations support the suggestion that colonies derived from heated spores are damaged versions of the parent form.

The changes produced in *T. elegans* did not affect all parts of the variants with the same intensity. The dwarf variant showed strong alteration of the vegetative system, and reduction in the size of the fructifications. The subnormal variant differed from normal chiefly in the formation of many large sporangia on short hyphae. The large-headed variant was specially distinguished by the production of loosely constructed heads with many sporangiola containing less than the normal average number of spores. It may be an accident, but it is interesting that the variant most altered in its fructification is also the most permanent of the variants investigated.

Modifications in *T. elegans*, directly related to the conditions of nutrition, have been observed by several investigators (1, 5, 7, 14). Of these, Brefeld alone suggested that the modifications were transmissible. He stated that alterations in the proportions in which the two sorts of sporangia were produced could be brought about by the use of thin or thick sowings of spores, and that the changes could be increased by repetitions of the treatment. Bachmann (1) was unable to confirm this. Tests made with the normal stock used in the present work showed that colonies developed in the same way whether started from one or from many spores; variations could not be induced by adjusting the density of the inoculum.

The variants of *T. elegans* grown from heated spores preserved their distinctive features when grown side by side in dishes poured from the same lot of potato agar; it is therefore evident that nutritive conditions were not responsible for the development of the special characters of the variants, nor for the persistence of these characters in series of cultures.

Numerous attempts were made to obtain zygospores, by growing the four forms of *T. elegans* in contrasted cultures; all failed. The induced changes in morphology and cultural behaviour were not accompanied by any change in sexual reaction.

The experimental results show that *T. elegans* can be induced to yield variant forms when the spores are exposed to relatively high temperatures for a short time, and then planted under ordinary conditions, but it is not yet possible to obtain a given variant at will. In

this respect the results of the experiments agree with those of other workers who have induced changes in a variety of organisms by the use of physical and chemical agents.


## Summary

1. Spores of *T. elegans* have yielded variant cultures, after exposure to moderately high temperatures.

2. The variants have preserved their distinguishing characters through a considerable number of transfers. Of three variants described in detail, one was still quite distinct from the normal form after having been in culture for more than three years.



## Acknowledgment

The provision of a microscope by the Government Grant Committee of the Royal Society is gratefully acknowledged.


## REFERENCES


(1) Bachmann, J. "Einfluss der äusseren Bedingungen auf die Sporenbildung von *Thamnidium elegans* Link." *Bot. Z.* LIII, I (1895), 107–30.

(2) Barnes, B. "Variations in *Eurotium herbariorum* (Wigg.) Link, induced by the action of high temperatures." *Ann. Bot.* XLII (1928), 783–812.

(3) —— "Variations in *Botrytis cinerea* Pers., induced by the action of high temperatures." *Ann. Bot.* XLIV (1930), 825–858.

(4) —— "Laboratory devices." *Trans. Brit. mycol. Soc.* XVIII (1933), 171–3.

(5) Brefeld, O. "Die Ascen der Ascomyceten in ihren Beziehungen zu den Basidien und zu einfacheren Fruchtformen." *Unters. a.d. Gesammtgeb. Mykol.* IX (1891), 59.

(6) Corda, A. C. I. *Icones fungorum*, III (1839), 14–15, and Pl. II, fig. 43.

(7) Dale, E. "On the fungi of the soil. Part II." *Ann. Mycol.*, Berl., XII (1914), 50.

(8) Dickson, H. "The effects of X-rays, ultraviolet light, and heat in producing saltants in *Chaetomium cochliodes* and other fungi." *Ann. Bot.* XLVI (1932), 389.

(9) —— "Saltation induced by X-rays in seven species of *Chaetomium*." *Ann. Bot.* XLVII (1933), 735–754.

(10) Fischer, A. *Rabenhorst's Kryptogamen-Flora*, I, 4 (1892), 241–4, and fig. 41.

(11) Muller, H. J. "The production of mutations by X-rays." *Proc. Nat. Acad. Sci.*, Wash., XIV (1928), 714–26.

(12) Ridgway, R. *Color Standards and Color Nomenclature.* Washington, D.C. (1912).

(13) Savulescu, T. and Rayss, T. "Der Einfluss der äusseren Bedingungen auf die Entwicklung der *Nigrospora Oryzae* (B. und Br.) Petch." *Phytopath. Z.* V (1932), 153–72.

(14) van Tieghem, P. and Le Monnier, G. "Recherches sur les Mucorinées." *Ann. Sci. nat. Bot.* V, XVII (1873), 321–8, and Pl. 23, figs. 57–60.

## EXPLANATION OF PLATES XIII AND XIV

### PLATE XIII

*Thamnidium elegans* Link.

Fig. 1. The large-headed variant.
Fig. 2. The normal form.
Fig. 3. The dwarf variant.
The cultures were grown side by side on dishes of potato agar poured from the same flask of medium; they were six days old when photographed. These cultures belonged to set 23, and the variants had been in culture for six months.
Figs. 4–5. The large-headed variant and the normal form, in cultures 21 days old. The cultures were sister cultures, and the variant had been in culture for a year, having passed through 35 transfers. The two cultures were photographed on the same plate, and the figures reproduced here were cut out from one print.
Fig. 6. Heads of the large-headed variant, showing the loose construction. × 40.
Fig. 7. Heads of the dwarf variant as they appeared for some months after the variant was isolated, × 100. The photograph was taken from a culture like that shown in Fig. 3.

### PLATE XIV

Figs. 8–10. Marginal hyphae of the large-headed variant, the normal form and the dwarf variant respectively, × 60. The width of the hyphae is exaggerated by fluid lying against them.
Figs. 11–13. Portions of cultures of the large-headed variant, the normal form and the dwarf variant, photographed when the investigation had been in progress for a year. By this time, the dwarf variant had increased in strength, and was producing a fair number of well formed heads of sporangiola. × 20.

Fig. 1

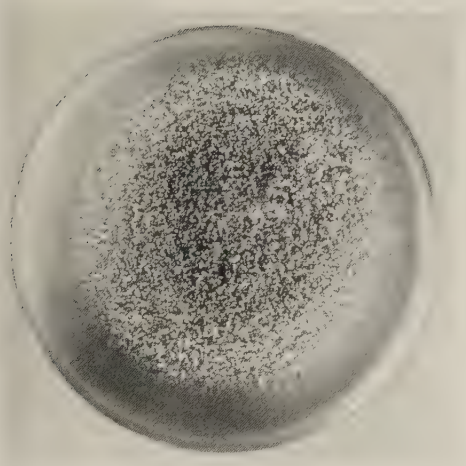


Fig. 2

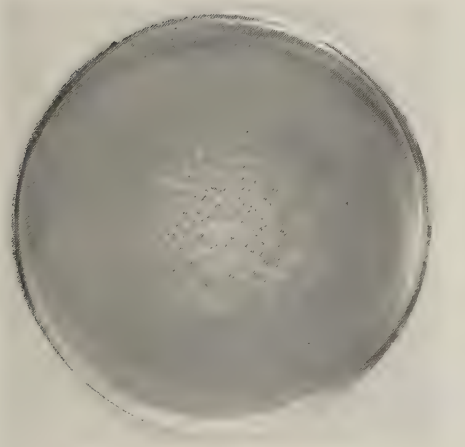


Fig. 3

Fig. 4

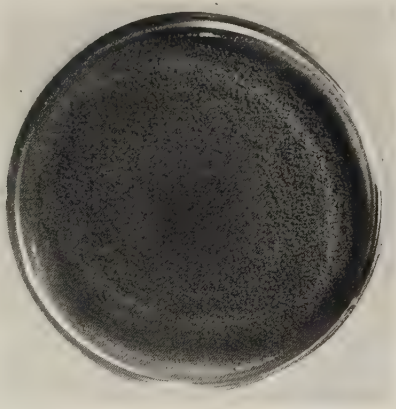


Fig. 5

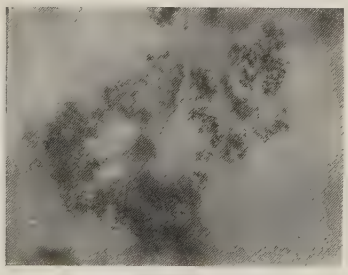


Fig. 6

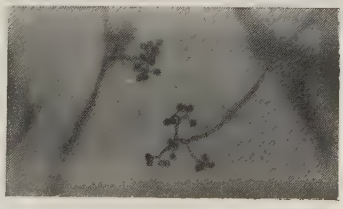


Fig. 7

Fig. 8

Fig. 11

Fig. 9

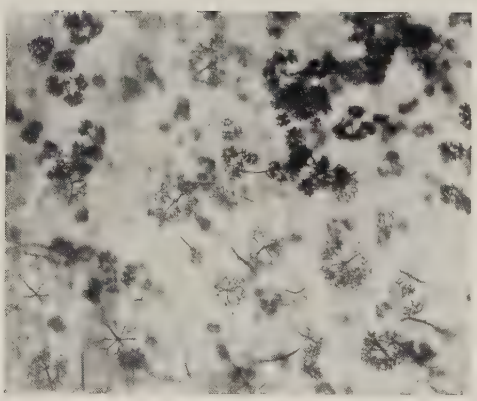


Fig. 12

Fig. 10

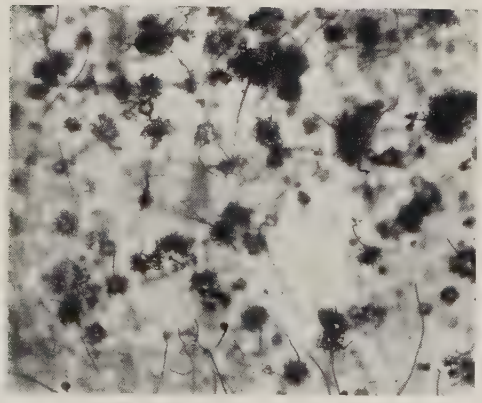


Fig. 13

# A LIST OF FUNGI, ETC., MAINTAINED IN THE NATIONAL COLLECTION OF TYPE CULTURES, 1935

By R. St JOHN-BROOKS and MABEL RHODES

During the five years that have elapsed since the publication of the last list of fungi, etc., maintained in the National Collection of Type Cultures (1) many new types have been added to the collection and, it is thought, the time is now opportune for the issue of a new and revised catalogue. The list of cultures here published comprises some twelve hundred different species of fungi and bacteria as compared with some seven hundred and seventy species listed in these *Transactions* in 1930. Among the many sources from which the collection has been enriched during this period special reference may be made to the large series of *Aspergillus* and *Penicillium* species, etc., lodged for maintenance by Prof. H. Raistrick, which were employed by him and his co-workers in their studies in the biochemistry of micro-organisms (2). These comprise some two hundred and twenty types, of which a considerable number are here listed; they are distinguished by the letters "R.C."

Early last year a working arrangement was made with the Director and staff of the Forest Products Research Laboratory, Princes Risborough, Bucks, whereby the extensive collection of wood-destroying fungi, and fungi causing discoloration in timber conserved by them, was made available for listing in the publications of the National Collection. This collection comprises some one hundred and eighty separate species, which are distinguished in the following list by the letters "F.P.R.L." Any applications for such lignicolous fungi received by the staff of the National Collection will be referred to the Forest Products Research Laboratory, who will deal with them direct. A small charge of 2*s*. 6*d*. per culture, which in some cases might be waived, will be made.

A complete reference to the bacteriological and mycological collection of the Bureau, as constituted in 1931, will be found in the catalogue published by the Medical Research Council in that year (3). A new and revised edition of this catalogue is in course of preparation and, it is hoped, will be published this year. It will naturally include bacteria of medical and veterinary importance, which are outside the scope of the present publication.

Following the recommendations of the Nomenclature Committee of the International Society for Microbiology, of which the Curator

of the National Collection is one of the permanent secretaries, the use of the specific name "*Bacillus*" has been restricted in the following list to spore-bearing bacteria. A pronouncement on this subject has already been made by the Committee and the publication of their report has been promised for an early date in the *Zentralblatt für Bakteriologie*. Most of the non-sporing bacteria have been listed, without prejudice, under "*Bacterium*", others under "*Lactobacillus*", "*Acetobacter*", etc.

The Nomenclature Committee also appointed a subcommittee to report on the taxonomy and nomenclature of the *Salmonella* group of "food-poisoning" organisms. The results of their labours, which however do not necessarily express the views of the Committee, are embodied in a report recently published in the *Journal of Hygiene* (4).

The reference numbers of the cultures maintained in the collection should be quoted in all applications for type cultures, for which a small charge will be made, in most cases, to cover the cost of media, packing and postage. Organisms that do not appear on the list will be procured for correspondents, if available elsewhere. It is hoped that colleagues at home and abroad will continue to support the collection both by requests for cultures and by the deposit of important strains for maintenance and reference. It is requested that all communications be addressed to The Curator, National Collection of Type Cultures, Lister Institute, Chelsea Bridge Road, London, S.W. 1.

2791 Absidia capillata v. Tiegh.
1790 A. coerulea Bain.
3098 A. glauca (+) Hagem
3099 A. glauca (−) Hagem
2792 A. Regneri (Lucet & Cost.) Lendn.
1345 Acetobacter aceti (Hansen) Holland
2224 A. acetosum (Henneberg) Bergey et al.
3924 A. Kuetzingianum (Hansen) Bergey et al.
613 A. Pasteurianum (Hansen) Beij.
3734 A. suboxydans Kluyver & de Leeuw
4112 A. xylinum (A. Br.) Bergey et al.
3015 Achorion Gallinae (Mègnin) Sabour.
3013 A. gypseum Bodin
3011 A. Quinckeanum Zopf
A. Schoenleinii. See Grubyella
3012 A. violaceum Bloch.
3826–3833 Achromobacter Bergey et al. spp. from slimy meat
706 Acladium Castellanii Pinoy
3145 Acremoniella olivaespora Cif. & Ashf.
1268 Acrostalagmus cinnabarinus Corda
3146 Acrotheca obovatum var. subcapitatulum Cif. & Ashf.
2958 Acrothecium lunatum Wakker
2393 Actinomyces africanus (Pijper & Pullinger) Westerdijk
3526 A. albido-flavus (Rossi Doria)
1578 A. albosporeus Kr.
3525 A. albus (Rossi Doria)
3258 A. asteroides (Eppinger) Gasp.
1574 A. aureus Waks. & Curt.
3440 A. bovis Wolff & Israel (anaerobic)
600 A. bovis Harz (aerobic)
3558 A. cacaoi I Waks.
3559 A. cacaoi II Waks.
3560 A. cacaoi III Waks.
1561 A. californicus Waks. & Curt.
659 A. caprae (Silb.) Lieske
3527 A. carneus (Rossi-Doria)
1934 A. caviae (Snijders)
1569 A. chromogenus Gasp.
2300 A. coelicolor (Reiner Müller) Lieske
1652 A. corallinus (Heff.)
1935 A. Cuniculi (Snijders)
803 A. Dassonvillei (Broque-Rousseau) Westerdijk

1564 A. Fradii Waks. & Curt.
1583 A. griseus Kr.
1585 A. Lipmannii Waks. & Curt.
576 A. luteus (Christoph. & Arch.) Westerdijk
3255 A. madurae (Vincent) Lehm. & Neum.
3026 A. Pelletieri (Laveran) Westerdijk
1566 A. pheochromogenus Conn.
2744 A. praecox Millard & Burr
2391 A. pretorianus (Pijper & Pullinger)
1565 A. reticuli Waks. & Curt.
1555 A. reticulus-ruber Waks.
2781 A. ruber (Carabo)
1562 A. rutgersensis Waks. & Curt.
1356 A. scabies (Thaxter) Güssow
2745 A. Setonii Millard & Burr
3236 A. somaliensis (Brumpt)
3524 A. sulphureus Gasp.
2392 A. transvalensis (Pijper & Pullinger)
2543 A. tumuli Millard & Beeley
1567 A. violaceus-ruber Waks. & Curt.
2746 A. viridis Millard & Burr
1580 A. virido-chromogenus Kr.
1554 A. 96 Waks.
1582 A. 104 Waks.
1584 A. 128 Waks.
1586 A. 145 Waks.
1581 A. 168 Waks.
1560 A. 206 Waks.
1571 A. 218 Waks.
658 A. sp. Birt-Leishman (human pathogen)
1870 A. sp. from Dhobie itch
630 A. sp. from foal
450 A. sp. Gibson (human pathogen)
1676 A. sp. Rangoon (human pathogen)
Aerobacillus Donker. See Bacillus
3249 Allescheria Boydii Shear (human pathogen)
A. Gayonii. See Eurotiopsis
2863 Alternaria Citri Ellis & Pierce
2964 A. macrospora Zimm.
2925 A. Solani (Ell. & Mart.) Jones & Grout
4467 A. tenuis Nees
4090–4092 A. spp., R.C.
605 Amylomyces sp. from tapioca
1314 Anthostomella destruens Shear
Aplanobacter E. F. Smith. See Bacterium
4004 Aposphaeria violacea Bertel
4255 Armillaria mellea (Vahl) Fr., F.P.R.L.
4256 A. mucida (Schrad.) Fr. F.P.R.L.
3323 Ascobolus furfuraceus Pers.
1945 Aspergillus Amstelodami (Mang.) Thom & Ch.
595 A. candidus Link
1325 A. carbonarius (Bain.) Thom
3774 A. cinnamomeus Schiem., R.C.
978 A. clavatus Desm.
3775 A. conicus Bloch., R.C.
3776 A. disjunctus Bain. & Sart., R.C.
973 A. effusus Tiraboschi
3777 A. ferrugineus Fuck. (A. glaucus gr.), R.C.
3778 A. ficuum (Reich.) Henn. (A. niger gr.), R.C.
3779 A. Fischeri Wehm., R.C.
3890 A. flavipes Bain. & Sart., R.C.
596 A. flavus Link
1693 A. fumaricus Wehm.
982 A. fumigatus Fres.
3780 A. giganteus Wehm., R.C.
2655 A. glaucus group (Ascosporic)
1017 A. luchuensis Inui
3782 A. medius Meiss., R.C.
3783 A. minimus Wehm. (A. glaucus gr.), R.C.
3784 A. mollis Bain. & Sart. (A. glaucus gr.), R.C.
795 A. nidulans (Eidam) Winter
3786 A. nidulans (Eidam) Winter var. Nicollei Pinoy, R.C.
594 A. niger v. Tiegh.
1692 A. niger-citricus Wehm.
979 A. ochraceus Wilh.
3787 A. Okazakii Okazaki, R.C.
598 A. Oryzae (Ahlb.) Cohn
3788 A. ostianus Wehm., R.C.
975 A. parasiticus Speare
1324 A. pulverulentus (McAlp.) Thom
3789 A. repens (Cda.) Sacc., R.C.
4155 A. restrictus Smith
4156 A. restrictus Smith var. B
3790 A. Scheelei Bain. & Sart., R.C.
2044 A. Schiemannii (Schiem.) Thom
980 A. Sydowii (Bain. & Sart.) Thom & Ch.
599 A. tamarii Kita
981 A. terreus Thom
974 A. terricola March. var. americanus March.
3757 A. ustus (Bain.) Thom & Ch., R.C.
3791 A. versicolor (Vuill.) Tiraboschi, R.C.
3792 A. violaceo-fuscus Gasp., R.C.
597 A. Wentii Wehm.
3925–3932 A. spp. (white), R.C.
2050 Atelosaccharomyces sp. Guilliermond

4184 Azotobacter agilis Beij.
1855 A. chroococcum Beij.
4229 Azygozygum chladodosporum Chesters
3322 Bacillus acetoethylicus (Northrop)
B. acetonigenus (Donker) Thaysen. See B. pectinovorus
2604 B. adhaerens Laubach
4254 B. aerothermophilus Weinzirl
2598 B. agri Laubach & Rice
2601 B. albolactis Migula
3324 B. alvei Cheshire & Cheyne
2870 B. aminovorans den Dooren de Jong
2590 B. aterrimus Lehm. & Neum.
2264 B. Beijerinckii (Donker)
2611 B. brevis Migula
619 B. butylicus Weizm.
1650 B. butyricus Hueppe (aerobe)
B. butyricus Prasmowski (anaerobe). See B. Pasteurianus
3716 B. butyricus-iodophilus Svartz
2690 B. calidolactis Hussong & Hammer
2599 B. cereus Frankland & Frankland
2600 B. cereus Fr. & Fr. var. fluorescens Laubach
2610 B. circulans Jordan
2584 B. closteroides Gray & Thorn.
2596 B. cohaerens Gottheil
927 B. dendroides Holzmüller
2121 B. distortus (Duclaux)
3472 B. esterificans Maassen
3220 B. felsineus Carbone & Tombolato
3461 B. filamentosus Cozzolino
2120 B. filiformis (Duclaux)
2608 B. fusiformis Gottheil
2123 B. geniculatus (Duclaux)
2593 B. Globigii Migula
2689 B. kaustophilus Prickett
3879 B. lactis Flügge
3427 B. lactomorbi Jordan & Harris
3388 B. larvae White
2613 B. laterosporus Laubach
3223 B. macerans Schardinger
2605 B. megaterium de Bary
B. megatherium. See B. megaterium
2589 B. mesentericus (Flügge) Lehm. & Neum.
2595 B. mesentericus (Flügge) L. & N. var. flavus Laubach
B. mesentericus fuscus. See B. mesentericus
B. mesentericus niger. See B. aterrimus
B. mesentericus panis viscosi. See B. panis
B. mesentericus ruber. See B. Globigii
B. mesentericus vulgatus. See B. vulgatus
4435 B. methanigenes Lehm. & Neum.
2122 B. minimus (Duclaux)
2602 B. mycoides Flügge
2736 B. niger Migula
2594 B. panis Migula
1649 B. Pasteurianus (Winogr.)
2263 B. pectinovorus (Beij. & van Delden)
2606 B. petasites Gottheil
1380 B. polymyxa (Prazm.) Migula
2603 B. Prausnitzii Trevisan
2609 B. pseudotetanicus (Kruse) Migula
2116 B. scaber (Duclaux)
2597 B. simplex Gottheil
3610 B. subtilis (Ehrerb.) Cohn (type strain)
2587 B. subtilis-viscosus Chester
1116 B. tenuis (Duclaux)
2612 B. terminalis Migula
2688 B. terminalis Migula var. thermophilus Prickett
3991 B. thermoacidurans Berry
3992 B. thermoacidurans Berry var. *a* Berry
3993 B. thermoacidurans Berry var. *b* Berry
2812 B. thermophilus Nègre
1490 B. Truffautii Truffaut & Bezssonoff
2607 B. tumescens Zopf
2588 B. vulgatus (Flügge) Migula
413 Bacterium acidi-lactici Hueppe
B. acidophilum. See Lactobacillus
1804 B. acridiorum (d'Herelle)
2872 B. aminovorans (den Dooren de Jong)
2870A B. aminovorans α (den Dooren de Jong)
2870B B. aminovorans β (den Dooren de Jong)
2871 B. aminovorans γ (den Dooren de Jong)
2872 B. aminovorans δ (den Dooren de Jong)
3681 B. amylovorum (Burrill) Serbinoff
3682 B. angulatum Fromme & Murray
1977 B. aptatum N. R. Br. & Jamieson
1987 B. aroideae (Townsend) Stapp
1986 B. atrofaciens McCullough
1953 B. atrosepticum (van Hall)
303 B. Barkeri (St. J.-B.) Elliott
2797 B. bifidum (Tissier)
4473 B. brunneum Copeland

B. bulgaricum. See Lactobacillus
2314 Bacterium "C" Chaston Chapman
2029 B. campestre (Pammel) E. F. Smith
1956 B. Cannae Bryan
1975 B. carotovorum (Jones)
1381 B. caryocyaneum (Beij.)
408 B. cloacae Jordan
4143 B. coli-anindolicum Lembke
86 B. coli-commune Esch.
419 B. communius (Durham)
3683 B. coronafaciens Elliott
3193 B. costatum (Cranston & Lloyd)
2580 B. cruciviae (Gray & Thorn.)
2572 B. cycloclastes Gray & Thorn.
4031 B. Delphinii (E. F. Smith) Bryan
1656 B. denitrificans (Burri & Stutz)
1385 B. denitrofluorescens-liquefaciens Kluyver
2578 B. desmolyticum Gray & Thorn.
1356 B. fluorescens-liquefaciens Flügge
912 B. fluorescens-nonliquefaciens Lehm. & Neum.
3875 B. fluorescens-putudum Flügge
3735 B. Freundii Braak
1174 B. fulvum Zimm.
2687 B. globiforme Conn
661 B. Guentheri Lehm. & Neum.
2880 B. herbicola Burri & Düggeli
387 B. Hyacinthi Wakker
2847 B. indicum-rubrum (Koch)
2760 B. indoloxidans (Gray)
2575 B. iopagum Gray & Thorn.
3693 B. Juglandis (Pierce) E. F. Smith
4252 B. lachrymans E. F. Smith & Bryan
418 B. lactis-aerogenes Esch.
3233 B. lactis-viscosum (Adametz) Lehm. & Neum.
3441 B. Lathyri (Manns & Taubenhaus)
3224 B. lipolyticum Evans
4248 B. Malvacearum (E. F. Smith) E. F. Smith
1981 B. marginale N. A. Br.
4469 B. mazuni Weigmann, Gruber & Huss
4239 B. medicagenis (Sackett) E. F. Smith var. phaseolicola (Burkholder) Link & Hall
1962 B. Michiganense E. F. Smith. See Corynebacterium
1966 B. Mori Boy. & Lam.
3797 B. mors-prunorum (Worm.)
2794 B. mucosum-capsulatum Fasching
414 B. neapolitanum Emmerich
2164 B. noctuarum White
3325 B. orpheus White
4141 B. oxytocum-perniciosum (Wysokovitsch)
3691 B. Panici Elliott
3324 B. paratyphosum-alvei (Bahr)
2686 B. parvulum Conn
3692 B. Pelargoni N. A. Br.
3685 B. Phaseoli E. F. Smith
3686 B. Phaseoli E. F. Smith var. sojense Hedges
1985 B. phytophthorum (Appel)
2576 B. pictorum (Gray & Thorn.)
2446 B. prodigiosum (Cohn) Lehm. & Neum.
394 B. proteamaculans (Paine & Stansfield) Elliott
4175 B. proteus-mirabilis (Hauser)
401 B. proteus-vulgaris (Hauser)
4176 B. proteus-zenkeri (Hauser)
3687B B. Pruni (E. F. Smith)
3370 B. prunicola (Worm.)
1999 B. pyocyaneum (Flügge) Lehm. & Neum.
2196 B. radicicola Beij.
1376 B. radiobacter (Beij.) Löhnis
2577 B. rathonis (Gray & Thorn.)
1655 B. rossicum Kell.
2796 B. rubefaciens Burr
2026 B. salmonicida Emmerich & Weibel
4249 B. seminum (Cayley) Stevenson
3272 B. solaniolens (Paine)
385 B. solanisaprum (Harrison)
2165 B. sphingidis White
1969 B. Stewartii (E. F. Smith) McCulloch
3246 B. syncyaneum (Ehrenb.) Lehm. & Neum.
2813 B. synxanthum Ehrenb.
1974 B. Syringae (van Hall) E. F. Smith
3689 B. tabacum Wolf & Foster
2881 B. tenue Ehrenb.
392 B. Tolaasii (Paine) Elliott
1983 B. tracheiphilum (E. F. Smith) Jones et al.
1967 B. trifoliorum Jones et al.
B. truttae. See B. salmonicida
1976 B. tumefaciens Smith & Townsend
1654 B. ureae Leube
4244 B. viridiflavum Burkholder
3727 B. viridilividum N. A. Br.
3688 B. vitians N. A. Br.
620 B. volutans Thaysen
972 Bacterium "X" A. Br.
3419 B. sp., from Allium sp., Matsumoto
2143 B. sp., from cutworm, Pospolov
933 B. sp., denitrifying

3197 B. sp., marine chromogenic, Lloyd
3418 B. sp., from "Pe-tsai", Matsumoto
3420 B. sp., from Phalaenopsis sp., Matsumoto
3275 B. sp., from turnip, Nirula
Bacteroides Cast. & Chalmers. See Bacterium
3100 Basidiobolus ranarum Eidam
1801 Beauveria Bassiana (Bals.) Vuill.
1659A B. densa (Link) Picard
2227 B. sp. aff. densa, fly, Ceylon
1142 B. globulifera (Speg.) Picard
2226 B. stephanoderis (Bally) Petch
2706 Betacoccus arabinosaceus Orla-Jensen
3128 Blakeslea trispora (+) Thaxt.
3129 B. trispora (−) Thaxt.
4463 Blastodendrion Flareri Red. & Cif.
3147 B. intermedium Cif. & Ashf.
Blastomyces. See Cryptococcus
Blastomycoides dermatitidis. See Cryptococcus
B. immitis. See Coccidioides
2688A B. tulanensis Cast. (human Pathogen)
2805 Blepharospora cambivora Petri
2523 Bodinea violacea (Bodin) Ota & Langer.
4006 Botryosporium diffusum (Grev.) Corda
1261 B. longibrachiatum (Oud.) Maire
852 Botrytis cinerea Pers.
1189 B. cinerea Pers., biological strain (fig)
1075 B. cinerea Pers., biological strain (quince)
2712 B. narcissicola Klebh.
1138 B. Paeoniae Oud.
2713 B. polyblastis Dowson
1496 B. Tulipae (Lib.) Hopk.
1832 Boudiera Claussenii Henn.
2811 Brettanomyces Claussen sp.
4145 Byssochlamys fulva Olliver & Smith
2201 Calonectria graminicola B. & Br.
1740 Candida breve Berkh.
C. candida. See Monilia
1739 C. Chodati Berkh.
4457 C. mycotoruloidea Red. & Cif.
2135 Caseococcus sp. Gorini
Cellulomonas Bergey et al. See Bacterium
1603 Cephalosporium Asteris Dowson
1859 C. longisporum Petch
1145 C. Sacchari Butl. See Fusarium moniliforme
4470 C. subverticillatum Schulz. & Sacc.
4480 C. Stuehmeri Schmidt & v. Beyma
1131 Cephalothecium roseum Corda
2517 Cercosporina Kikuchii Matsumoto
1315 Ceuthospora lunata Shear
4007 Chaetocladium Brefeldii (+) v. Tiegh. & le Monn.
4008 C. Brefeldii (−) v. Tiegh. & le Monn.
4020 Chaetomium convolutum Chivers
3309 C. panosum Wallr.
4100 C. sp., R.C.
3184 Chalara mycoderma Bonord.
3109 Chlamydomyces Palmarum (Cooke) Mason
2801 Choanephora Cucurbitarum (+) (B. & Rav.) Thaxter
2802 C. Cucurbitarum (−) (B. & Rav.) Thaxter
3073 Chromobacterium hibernicum Grimes
2537 C. violaceum Bergonzoni
2416 C. viscosum Grimes
1791 Circinella minor Lendn.
2793 C. spinosa v. Tiegh, & le Monn.
Citrobacter Werkman & Gillan. See Bacterium
606 Citromyces B Wehmer. See Penicillium glabrum
1182 Cladosporium fulvum Cooke
2278 C. herbarum Link
2783 C. Mansonii Cast.
4079–4081 C. spp., R.C.
3043 Clasterosporium maydicum Sacc.
4094–4095 C. spp., R.C.
Clostridium Prazmowski. See Bacillus
833 Coccidioides immitis Rixf. & Gilchr. (human pathogen)
Cocco-bacillus. See Bacterium
836 C. sp. from oyster
2145 Coccus sp. from cutworm. Pospolov.
555 C. sp. from Emmentaler cheese
4138 C. sp. Henrici, pleomorphic
3849 Colletotrichum atramentarium (B. & Br.) Taub.
1947 C. Camilliae Mass.
3501 C. gloeosporioides (Penz.) Sacc.
1606 C. Lindemuthianum (Sacc.) Bres.
1194 C. linicola Pethyb. & Laff.
1130 C. phomoides (Sacc.) Chester
4257 Collybia fusipes (Bull.) Berk., F.P.R.L.

4258 C. velutipes (Curt.) Fr., F.P.R.L.
4259 Coniophora cerebella Alb. & Schwein., F.P.R.L.
1948 Coniothecium chromatosporum Corda
1768 Coniothyrium convolutum Horne & Horne
4260 Coprinus micaceus (Bull.) Fr., F.P.R.L.
4261 C. radians (Desm.) Fr., F.P.R.L.
4262 Corticium radiosum Fr., F.P.R.L.
4214 Corynebacterium filamentosum H. L. Jensen
4212 C. helvolum (Zimm.) Kisskalt & Berend.
4213 C. insidiosum (McCulloch) var. saprophyticum H. L. Jensen
4217 C. michiganense (E. F. Smith) H. L. Jensen var. saprophyticum H. L. Jensen
4218 C. nubilum (P. & C. Frankland) H. L. Jensen var. nanum H. L. Jensen
4215 C. simplex H. L. Jensen
4216 C. tumescens H. L. Jensen
3679 Coryneum microstictum B. & Br. var. Mali Kidd
2075 Cryptococcus Castellanii Re
2787 C. dermatitidis Gilchr. & Stokes (human pathogen)
767 C. farciminosus Rivolta & Micellone
2077 C. gracilloides Cast.
1492 C. histolyticus (Freeman & Weidman)
3599 C. hominis (Busse) Vuill.
2577 C. linguae-pilosae (Raynard & Lucet) Vuill.
1869 C. macroglossiae Cast.
2772 C. metaniger Cast.
885 C. nasalis (Harrison)
3598 C. neoformans (Sanfelice) Vuill.
2774 C. pararoseus Cast.
4455 C. Pinoyisimilis Cast.
4456 C. Pinoyisimilis Cast. var. Citelliana Red. & Cif.
2773 C. rubrorugosus Cast.
2673 C. sp. Hildebrand strain
4158 C. sp. Pijper
2674 C. sp. Sax strain
1792 Cunninghamella echinulata Thaxt.
3101 C. elegans (+) Lendn.
3102 C. elegans (−) Lendn.
4263 Cyathus striatus (Huds.) Pers., F.P.R.L.
2511 Cylindrocarpon Mali (All.) Wr.
1294 Cytosporina ludibunda Sacc.
1184 C. Ribis P. Magn.
4264 Daedalea biennis (Bull.) Quél., F.P.R.L.
4265 D. confragosa (Bolt.) Fr., F.P.R.L.
4266 D. quercina (Linn.) Fr., F.P.R.L.
4267 D. unicolor (Bull.) Fr., F.P.R.L.
4268 Daldinia concentrica (Bolt.) Ces. & de Not., F.P.R.L.
477 Debaryomyces globosus Klöck.
2059 D. Klöckeri Guill. & Péju
3593 D. Matruchoti Grig. & Péju
2048 D. tyrocola Konokotine
Dematium pullulans. See Pullularia
1682 Diaporthe perniciosa March., forma Pruni Cayley
4009 Didium aurantium
1474 Diplodia natalensis Evans
1009 Diplodiella sp.
1133 Diplodina Lycopersici (Cooke) Hollós
Discomyces Rivolta. See Actinomyces
4269 Echinodontium tinctorium E. & H., F.P.R.L.
1766 Eidamia catenulata Horne & Williamson
1765 E. tuberculata Horne & Jones
1764 E. viridescens Horne & Williamson
703 Endodermophyton indicum Cast.
1758 E. tropicale Cast.
Endomyces. See Endomycopsis
3592 E. Magnusii Ludwig
3603 Endomycopsis bisporus (Beck) Dekker
1871 E. fibuliger (Lindn.) Dekker
1908 E. fibuliger (Lindn.) Dekker var. Hordei Saito
2045 E. fibuliger (Lindn.) Dekker var. Lindneri Saito
3601 E. javanensis (Klöck.) Dekker
3602 E. Mali (Lewis) Dekker
2241 E. vernalis (Ludwig) Dekker
4098–4099 Epicoccum spp., R.C.
2780 Epidermophyton cruris Cast.
3016 E. Pernetii Cast.
702 E. rubrum Cast.
3579 E. simii Pinoy
3310 Eremascus fertilis Stoppel
Erwinia Winslow et al. See Bacterium
Escherichia Cast. & Chalmers. See Bacterium
4270 Favolus canadensis Klotz., F.P.R.L
4271 Fistulina hepatica (Huds.) Fr., F.P.R.L.
4272 Flammula sapinea Fr., F.P.R.L.
Flavobacterium Bergey et al. See Bacterium

4273 Fomes annosus Fr., F.P.R.L.
F. applanatus. See Ganoderma
4275 F. conchatus (Pers.) Fr., F.P.R.L.
4276 F. connatus Fr., F.P.R.L.
4277 F. ferruginosus (Schrad.) Massee, F.P.R.L.
4278 F. fraxineus (Bull.) Fr., F.P.R.L.
4279 F. fraxinophilus (Peck.) Sacc., F.P.R.L.
4280 F. igniarius (Linn.) Fr., F.P.R.L.
4281 F. juniperinus Schrenk, F.P.R.L.
4282 F. Laricis (Jacq.) Murrill, F.P.R.L.
4283 F. nigricans Fr., F.P.R.L.
4284 F. pinicola (Sw.) Cke., F.P.R.L.
2169 F. pinicola (Sw.) Cke. var. marginalis
4285 F. pomaceus (Pers.) Big. Guill, F.P.R.L.
4286 F. Ribis (Schum.) Fr., F.P.R.L.
4287 F. rimosus Berk., F.P.R.L.
4288 F. robustus Karst., F.P.R.L.
4289 F. roseus (A. & S.) Fr., F.P.R.L.
4290 F. scutellatus Schwein., F.P.R.L.
F. tinctorium. See Echinodontium
4291 F. vinosus Berk., F.P.R.L.
3505 Fragosphaeria purpurea Shear
4373 Fumago vagans Pers.
1770 Fusarium acuminatum (Ell. & Ev.) Wr.
2710 F. avenaceum (Fr.) Sacc.
3793 F. bulbigenum Cke. & Mass.
1141 F. coeruleum (Lib.) Sacc.
2709 F. culmorum (W. G. Sm.) Sacc.
2735 F. culmorum (W. G. Sm.) Sacc. var. leteius Sherb.
1136 F. Dianthi Prill. & Del.
4062 F. falcatum App. & Wr., R.C.
3097 F. fructigenum Fr.
2711 F. herbarum (Corda) Fr.
2862 F. javanicum Koorders
2509 F. juruanum P. Henn
1081 F. Lini Bolley
1767 F. Malli Taub.
4054 F. Martii App. & Wr., R.C.
4067 F. metachroum App. & Wr., R.C.
3794 F. moniliforme Sheld., R.C.
4069 F. orthoceras App. & Wr., R.C.
4071 F. oxysporum Schl., R.C.
4066 F. rhizophilum Corda, R.C.
4060 F. Salicis Fuck., R.C.
4064 F. sambucinum Fuck., R.C.
4070 F. Scirpi Lamb. & Fautr., R.C.
4053 F. Solani (Mart.) App. & Wr. var. minus Fr., R.C.
1296 F. sporotrichioides Sherb.
4057 F. trichotechioides Wr., R.C.
4058 F. tuberculariodes (Corda) Sacc., R.C.
4056 F. uncinatum Wr., R.C.
1696 F. vasinfectum Atk.
3300 F. vasinfectum Atk. var. aegypticum Fahmy
4052 F. viride Wr., R.C.
4055–4068 F. spp., R.C.
4292 Ganoderma applanatum (Pers.) Pat., F.P.R.L.
4293 G. lucidum (Leyss.) Karst., F.P.R.L.
4294 G. oregonense Murr., F.P.R.L.
4295 G. resinaceum Boud., F.P.R.L.
Geotrichum immite. See Coccidioides
4472 G. javanense Verona
4106 Gibberella Saubinetii (Mont.) Sacc.
1454 Gliocladium penicillioides Corda
1730 G. roseum Bain.
2513 Gloeosporium fructigenum Berk.
1797 G. limetticola Claussen
1390 G. Musarum Cke. & Mass.
1839 G. nervisequum (Fuck.) Sacc.
3552 G. pestis Mass.
1317 Glomerella rufomaculans-Vaccinii Shear
1861 Gonatorrhodiella coccorum Petch
Granulobacter Beij. See Bacillus
2527 Grubyella Schoenleinii (Lebert) Ota & Langer.
3326 Guignardia Vaccinii Shear
3311 Gymnoascus Reessii Baran.
817 Hansenia apiculata (Reess) Lindn.
816 H. apiculata Schmitz
478 Hanseniaspora valbyensis Klöck
Hansenula. See Willia
3551 Haplosporangium bisporale Thaxter
3877 Helicostylum nigricans v. Tiegh.
1793 H. piriforme Bain.
4010 Helminthosporium AvenaeEidam
4082 H. geniculatum Tracy & Earle, R.C.
4087 H. gramineum Rabenh., R.C.
1319 H. inaequale Shear
4086 H. interseminatum Berk. & Rav., R.C.
1357 H. Sacchari Butl.
1888 H. sativum Pam., King & Bakke
4083 H. teres Sacc., R.C.
4085 H. sp., R.C.
2778 Hemispora pararugosa Cast., Doug. & Thomp.
705 H. rugosa Cast.
2769 H. stellata Vuill.
2186 Hendersonia Sacchari Butl.
4088 Heterosporium gracile Sacc., R.C.
4089 H. variable Cke., R.C.

4296 Hexagonia discopoda Pat. & Hariot, F.P.R.L.
2893 Hormodendrum Langeronii da Fonseca, Leão & Penido
4297 Hydnum coralloides (Scop.) Fr., F.P.R.L.
4298 Hypholoma fasciculare Huds., F.P.R.L.
4299 H. hydrophilum (Bull.) Quél., F.P.R.L.
4300 H. perplexum (Peck) Dacc., F.P.R.L.
4301 H. sublateritium Schaeff., F.P.R.L.
4302 H. velutinum (Pers.) Fr., F.P.R.L.
3415 Hypochnus sasakii Shirai
H. Solani. See Rhizoctonia
4303 Irpex destruens Petch, F.P.R.L.
4304 I. obliquus (Schrad.) Fr., F.P.R.L.
2957 Isaria farinosa (Dicks) Fr.
Kloeckera Janke. See Pseudosaccharomyces
Kurthia Trevisan. See Bacterium
1320 Lachnea abundans (Karst.) Sacc.
3312 L. cretea (Cke.) Phill.
4034 Lactobacillus acidophil-aerogenes (Torrey & Rahe) Bergey et al.
1899 L. acidophilus (Moro) Holland
76B L. bulgaricus (Grigoroff) Holland
2375 L. Delbrueckii (Leichm.) Holland
4036 L. fermentatae Bergey et al.
4113 L. helviticus (Orla-Jensen) Bergey et al.
4035 L. leichmannii (Henneberg) Bergey et al.
4114 L. lycopersici Mickle
947 L. pentoaceticus Fred., Peterson & Davenport
L. plantarum. See Streptobacterium
4305 Lentinus cochleatus (Pers.) Fr., F.P.R.L.
4306 L. Lecomptei Fr., F.P.R.L.
4307 L. lepideus Fr., F.P.R.L.
4308 L. tigrinus (Bull.) Fr., F.P.R.L.
4309 Lenzites abietina Bull., F.P.R.L.
4310 L. betulina (Linn.) Fr., F.P.R.L.
4311 L. bicolor Falck, F.P.R.L.
4312 L. flaccida Fr., F.P.R.L.
4313 L. saepiaria (Wulf.) Fr., F.P.R.L.
4314 L. trabea Pers., F.P.R.L.
2170 Leptothrix sp. (human pathogen)
3739 Leuconostoc citrovorum (Hammer) Huck. & Ped.
3354 L. dextranicum (Beij.) Huck. & Ped.
3351 L. mesenteroides (Cienk.) v. Tiegh.
4315 Lycoperdon pyriforme (Schaeff.) Pers., F.P.R.L.
3677 Macrophomma phaseoli (Maubl.) Ashby
4474 Macrosporium commune Rabh.
2280 M. sarcinula Berk.
3235 Madurella mycetomi Brumpt
3027 Malassezia Baillon sp. from Tinea flava
3273 Margarinomyces Bubakii Laxa
Melanospora destruens. See Anthostomella
2185 M. pampeana Speg.
1862 M. parasitica Tul.
3704 Memnoniella echinata (Riv.) Galloway
4316 M. Merulius corium Fr., F.P.R.L.
4317 M. lachrymans (Wulf.) Fr., F.P.R.L.
4318 M. minor Falck., F.P.R.L.
4319 M. sclerotiorum Falck., F.P.R.L.
4320 M. serpens (Tode) Fr., F.P.R.L.
4321 M. sylvester Falck, F.P.R.L.
1660 Metarrhizium anisopliae (Metsch.) Sor.
2676 Micrococcus agilis Ali-Cohen
1630 M. aurantiacus Cohn
1657 M. candicans Flügge
4161 M. caseolyticus Evans
1628 M. concentricus Zimm.
2677 M. conglomeratus Migula
1629 M. flavus (Flügge) Lehm. & Neum.
2679 M. Freudenreichii Guillebeau
3873 M. lactis-viscosus Sternberg
2680 M. luteus (Schröt) Cohn
2665 M. lysodeikticus Fleming
2558 M. piltonensis Gray & Thorn.
2682 M. rhodochrous Zopf.
1114 M. roseus (Bumm.) Lehm. & Neum.
2559 M. sphaeroides Gray & Thorn
1631 M. sulphureus Zimm.
951 M. tetragenus Koch & Gaffky
2684 M. ureae Cohn
2685 M. varians Migula
3090 Microcyclus aquaticus Ørskov
3853 Micromonospora chalceae (Foulerton) H. L. Jensen
3856 M. coerulea H. L. Jensen
3854 M. fusca H. L. Jensen
3855 M. parva H. L. Jensen
1749 Microspira agarliquefaciens Gray & Chalmers
Microsporum Audouini. See Sabouraudites
3008 M. equinum Bodin
3009 M. ferrugineum Ota
M. felineum. See Sabouraudites

3007 M. fulvum Uriburu
2106 M. Japon Kambayashi
3313 Monascus purpureus Went
714 Monilia albicans (Robin) Zopf
2855 M. Ashfordii Cast.
2856 M. butantanensis Cast.
922 M. candida Bon.
2858 M. fusca Browne
2850 M. javanica Went. & Geer.
698 M. krusei Cast.
697 M. macedoniensis Cast.
2776 M. metalondinensis Cast.
2851 M. nigra Burri & Staub
2853 M. parapsillosis Ashf.
707 M. Pinoyi Cast.
2775 M. pseudotropicalis Cast.
2852 M. psilosis Ashf.
3590 M. sitophila (Mont.) Sacc.
696 M. tropicalis Cast.
2755 M. variabilis Lindn.
4458 M. zeylanoides Cast.
2146 M. sp., from "cutworm", Pospolov
2505 M. sp., from tongue (human pathogen)
3694 Monosporium acuminatum Bon. v. terrestre Sacc.
3105 Mortierella candelabrum v. Tiegh. & le Monn.
3150 M. niveo-velutina Cif. & Ashf.
3106 M. reticulata v. Tiegh. & Le Monn.
1903 Mucor alternans v. Tiegh.
1904 M. erectus Bain.
2010 M. hiemalis (+) Wehm.
2011 M. hiemalis (−) Wehm.
1901 M. javanicus Wehm.
1121 M. lusitanicus Brüderlein
3231 M. Moelleri Vuill.
3744 M. Mucedo (+) Linn.
3745 M. Mucedo (−) Linn.
1123 M. plumbeus Bon.
1902 M. pusillus Lindt
1122 M. racemosus Fres.
921 M. Rouxii Wehm.
1126 M. sphaerosporus Hagem
1821 M. spinosus v. Tiegh.
M. stolonifer. See Rhizopus nigricans
4322 Mycena galericulata Scop., F.P.R.L.
2571 Mycobacterium actinomorphum Gray & Thorn.
2562 M. agreste Gray & Thorn.
1470 M. album Söhn
2570 M. coeliacum Gray & Thorn.
2568 M. convolutum Gray & Thorn.
2566 M. crystallophagum Gray & Thorn.
4219 M. equi (Magnusson) H. L. Jensen
2569 M. erythropolis Gray & Thorn.
2761 M. globerulum Gray
1472 M. lactocola Söhn.
1469 M. luteum Söhn.
2275 M. marinum Aronson
2874 M. opacum den Dooren de Jong
525 M. Phlei (Möller) Lehm. & Neum.
1471 M. Phlei Söhn.
4220 M. rubro-pertinctum (Heff.) Ford
1468 M. rubrum Söhn.
2873 M. salmonicolor den Dooren de Jong
53 M. smegmatis (Alverez & Tavel) Lehm. & Neum.
526 M. Stercoris Bergey et al. (Möller's "Mist" Bacillus)
2071 M. sp. Karlinski
Mycocandida Red. & Cif. See Cryptococcus
1849 Mycoderma arborescens Kufferath
1848 M. Bordetii Kufferath
819 M. cereviseae Desm., Hansen
2055 M. Chevalieri Guill.
3021 M. cutaneum Ota (human pathogen)
3347 Mycogone perniciosa Magn.
2561 Mycoplana bullata Gray & Thorn.
2560 M. dimorpha Gray & Thorn.
4461 Mycotorula dimorpha Red. & Cif.
1842 M. famata Harrison
M. Pinoyi. See Monilia
4462 M. trimorpha Red. & Cif.
4460 M. verticillata Red. & Cif.
1843 M. vesica Harrison
M. zeylanoides. See Monilia
3331 Mystrosporium adustum Massee
1846 Nadsonia fulvescens Syd.
1143 Nectria diversispora Petch
1795 N. Ipomoeae Hals.
3675 Nematospora Coryli Pegl.
3411 N. Gossypii Ashby & Nowell
3314 Neocosmospora vasinfecta E. F. Smith
3411 Neurospora crassa Shear & Dodge
2500 Nigrospora Oryzae (B. & Br.) Petch
Nocardia Trevisan. See Actinomyces
Oidium albicans. See Monilia
700 O. asteroides Cast.
2886 O. lactis Fres.
2777 O. matalense Cast.

701 O. rotundatum Cast.
3087 O. sp. Chaston Chapman (from factory effluent)
2103 Omphalia flavida (Cke.) Maubl. & Rangel
3500 Oospora Citri-aurantii (Ferr.) Sacc. & Syd.
1742 O. fragrans (Kzr.) Berkh. var. minuta Berkh.
1743 O. humi (Mazé) Berkh.
3532 Paecilomyces hibernicum Kenn. & Grimes
3089 P. Varioti Bain.
1241 P. sp. Segal
4323 Panus stipticus (Bull.) Fr., F.P.R.L.
4324 P. torulosus (Pers.) Fr., F.P.R.L.
1062 Parasaccharomyces Ashfordii Anderson
4325 Paxillus panuoides Fr., F.P.R.L.
3943 Penicillium aurantio-violaceum Biourge, R.C.
984 P. avellaneum Thom. & Turesson
3956 P. baculatum West., R.C.
3940 P. Biourgeianum Zal., R.C.
P. brevicaule. See Scopulariopsis
P. brevicaule var. album. See Scopulariopsis
3568 P. brevi-compactum Dierckx
582 P. camemberti Thom
P. camemberti var. Rogeri. See P. caseicola
P. candidum Roger & Mazé. See P. caseicola
583 P. caseicola Bain.
4154 P. Charlesii Smith
589 P. chrysogenum Thom
3539 P. citrinum Thom, R.C.
1718 P. claviforme Bain.
3974 P. commune Thom, R.C.
4039 P. corymbiferum Westl., R.C.
4002 P. crustosum Thom, R.C.
3800 P. Daleae Zal., R.C.
3947 P. digatatum Sacc., R.C.
P. divaricatum. See Paecilomyces Varioti
587 P. Duclauxii Delacr.
P. elongatum. See P. tardum
593 P. expansum Link
3975 P. fusco-glaucum Biourge, R.C.
3944 P. glabrum (Wehm.) Westl., R.C.
3994 P. Gladioli Machacek, R.C.
P. glaucum. See P. terrestre
3977 P. Godlewskii Zal., R.C.
1720 P. granulatum Bain.
3565 P. Hagemi Zal.
1721 P. herquei Bain. & Sart.
3566 P. hirsutum Dierckx
3499 P. italicum Wehm.
4041 P. kiliense Weidemann, R.C.
3973 P. lanoso-coeruleum Thom, R.C.
3972 P. lanoso-viride Thom, R.C.
3799 P. lanosum Westl., R.C.
584 P. lilacinum Thom
585 P. luteum Zukal
3958 P. meleagrinum Biourge, R.C.
4222 P. notatum Westl.
3971 P. ochraceum Bain.-Thom, R.C.
P. olivaceum. See P. digatatum
983 P. oxalicum Currie & Thom
4151 P. pallidum Smith
1722 P. patulum Bain.
3936 P. Pfefferianum (Wehm.) Westl., R.C.
1151 P. pinophilum Hedgcock
3968 P. puberulum Bain., R.C.
586 P. purpurogenum Stoll
4153 P. Raistrickii Smith
588 P. roqueforti Thom
P. roseum. See Gliocladium
592 P. rugulosum Thom
4038 P. Schneggii Boas, R.C.
3029 P. solitum Westl.
4042 P. spiculosporum Lehman, R.C.
591 P. spinulosum Thom
3950 P. Steckii Zal., R.C.
1719 P. tardum Thom
3978 P. terrestre Jensen, R.C.
4152 P. varians Smith
3997 P. verrucosum Dierckx, R.C.
3567 P. vesiculosum Bain.
3998 P. viridicatum Westl., R.C.
4326 Peniophora gigantea Fr., F.P.R.L.
4327 P. incarnata (Pers.) Cke., F.P.R.L.
4328 P. quercina (Pers.) Cke., F.P.R.L.
4329 P. sanguinea (Fr.) Bres., F.P.R.L.
3276 Periconia felina E. March.
3680 Pestalozzia Hartigii Tubeuf.
1299 P. Palmarum Cooke
1259 P. Theae Sawada
3514 P. versicolor Speg.
4330 Phebia merismoides Fr., F.P.R.L.
3366 Phialophora verrucosa Medlar (human pathogen)
4331 Pholiota adiposa Fr., F.P.R.L.
4332 P. albo-crenulata Peck, F.P.R.L.
4333 P. heteroclita Fr., F.P.R.L.
4334 P. lucifera (Lasch.) Fr., F.P.R.L.
4335 P. mutabilis (Schaeff.) Quél., F.P.R.L.
4336 P. spectabilis Fr., F.P.R.L.
4337 P. squarrosa (Müll.) Fr., F.P.R.L.
1135 Phoma alternariaceum Brooks & Searle
1950 P. Betae Frank
2656 P. Lingam (Tode) Desm.
1798 P. Pomi Pass.

1088 Phomopsis sp. from plum
2653 Photobacterium phosphorescens (Fischer) Beij.
1383 P. phosphorium Beij.
2894 Phycomyces nitens (+) Kunze
2895 P. nitens (−) Kunze
1799 Physalospora Cydoniae Arnaud
3385 P. Miyabeana Fukushi
Phytomonas Bergey et al. See Bacterium
2807 Phytophthora Arecae (Colem.) Pethyb.
3062 P. Boehmeriae Sawada
2082 P. Cactorum (Lib. & Cohn) Schröt
3061 P. Capsici Leon.
2804 P. Cinnamomi Rands
3057 P. citricola Saw.
3134 P. Colocasiae Rac.
2803 P. cryptogea Pethyb. & Laff.
2069 P. erythroseptica Pethyb.
1193 P. Fagi Hart.
3058 P. hydrophila Curzi
P. infestans (Mont.) de Bary
2808 P. Meadii McRae
3550 P. megasperma Drechs.
3063 P. melongenae Saw.
1752 P. palmivora Butl.
3132 P. palmivora Butl., rubber group
3133 P. palmivora Butl., cacao group
2080 P. parasitica Dastur
2809 P. Pini Leon.
3299 P. Porri Forster
2806 P. Richardiae Buis.
3055 P. Syringae Kleb.
3060 P. Tabaci Saw.
481 Pichia alcoholophila Klöck.
483 P. calliphorae Klöck.
3594 P. Chodati (Zender) Dekker
3595 P. Chodati (Zender) Dekker var. Trumpyi (Zender) Dekker
901 P. farinosa Lindn.-Hansen
3863 P. hyalospora Lindn.
479 P. membranaefaciens Hansen
480 P. polymorpha Klöck.
482 P. suaveolens Klöck.
4011 Piptocephalis Freseniana de Bary
3107 P. sp. Wilkins
3412 Piricularia Oryzae Cav.
3025 Pityosporum rhinoserosum Sabour.
3327 Pleospora pomorum Horne
1451 Pleurage verruculosis Jensen
4338 Pleurotus euosmus (Berk.) Cke., F.P.R.L.
4339 P. lignatilis Fr., F.P.R.L.
4340 P. ostreatus (Jacq.) Fr., F.P.R.L.
4341 P. palmatus (Bull.) Quél., F.P.R.L.
4342 P. sapidus Schulz., F.P.R.L.
4343 P. ulmarius Bull., F.P.R.L.
4344 Pluteus cervinus (Schaeff.) Fr., F.P.R.L.
1761 Polyopeus aureus Horne
3678 P. purpureus Horne var. verus Horne
4345 Polyporus adustus Fr., F.P.R.L.
4346 P. albo-sordescens Rom., F.P.R.L.
4347 P. anceps Peck, F.P.R.L.
4348 P. balsameus Peck, F.P.R.L.
4349 P. benzoinus (Wahlenb.) Fr., F.P.R.L.
4350 P. Berkeleyi Fr., F.P.R.L.
4351 P. betulinus (Bull.) Fr., F.P.R.L.
4352 P. borealis (Wahlenb.) Fr., F.P.R.L.
4353 P. brumalis (Pers.) Fr., F.P.R.L.
4354 P. caesius (Schrad.) Fr., F.P.R.L.
4355 P. chioneus Fr., F.P.R.L.
4356 P. circinatus Fr., F.P.R.L.
4357 P. conchifer Schwein., F.P.R.L.
4358 P. croceus (Pers.) Fr., F.P.R.L.
4359 P. dryadeus (Pers.) Fr., F.P.R.L.
4360 P. dryophilus (Berk.) var. vulpinus, F.P.R.L.
4361 P. elegans (Bull.) Fr., F.P.R.L.
4362 P. fragilis Fr., F.P.R.L.
4363 P. frondosus Fr., F.P.R.L.
4364 P. fumosus (Pers.) Fr., F.P.R.L.
4365 P. giganteus (Pers.) Fr., F.P.R.L.
4366 P. gilvus Schwein., F.P.R.L.
4367 P. graveolens Schwein, F.P.R.L.
4368 P. guttulatus Peck, F.P.R.L.
4369 P. hispidus (Bull.) Fr., F.P.R.L.
4370 P. intybaceus Fr., F.P.R.L.
4371 P. lacteus (Bull.) Fr., F.P.R.L.
4372 P. nummularius (Bull.) Quél., F.P.R.L.
4373 P. orientalis Lloyd, F.P.R.L.
4374 P. picipes Fr., F.P.R.L.
4375 P. pubescens (Schum.) Fr., F.P.R.L.
4376 P. radiatus (Sow.) Fr., F.P.R.L.
4377 P. resinosus (Schum.) Quél., F.P.R.L.
4378 P. rutilans (Pers.) Fr., F.P.R.L.
4379 P. Schweinitzii Fr., F.P.R.L.
4380 P. spumeus (Sow.) Fr. var. mongolicus Murashk., F.P.R.L.
4381 P. squamosus (Huds.) Fr., F.P.R.L.
4382 P. sulphureus (Bull.) Fr., F.P.R.L.
4383 P. rheades Pers., F.P.R.L.
P. Tamariscis (Pat.) Sacc. & D. Sacc. See P. rheades
4384 P. tephroleucus Fr., F.P.R.L.
4385 P. Tsugae (Murr.) Overholt, F.P.R.L.
4386 P. tuberaster Fr., F.P.R.L.

4387 P. tulipiferus (Schwein.) Overholt F.P.R.L.
4388 P. varius (Pers.) Fr., F.P.R.L.
4389 P. vulpinus Fr., F.P.R.L.
4390 P. zonatus (Nees) Fr., F.P.R.L.
1004 Polyspora Lini Laff.
4391 Polystictus abietinus (Dicks.) Fr., F.P.R.L.
4392 P. cinnabariensis, F.P.R.L.
4393 P. hirsutus (Wulf.) Fr., F.P.R.L.
4394 P. sanguineus (L.) Mey,, F.P.R.L.
4395 P. versicolor (Linn.) Fr., F.P.R.L.
4396 Poria crassa Karst., F.P.R.L.
4397 P. ferruginea-fusca Karst., F.P.R.L.
4398 P. hypolateritia Berk., F.P.R.L.
4399 P. incrassata (B. & C.) Burt., F.P.R.L.
4400 P. laevigata Fr., F.P.R.L.
4401 P. obducens (Pers.) Fr., F.P.R.L.
4402 P. punctata Fr., F.P.R.L.
4403 P. subacida Peck, F.P.R.L.
4404 P. tsugina, F.P.R.L.
4405 P. Vaillantii (DC.) Fr., F.P.R.L.
4406 P. vaporaria (Pers.) Fr., F.P.R.L.
4407 P. xantha Lind., F.P.R.L.
3489 Proactinomyces minimus H. L. Jensen
3488 P. paraffinae H. L. Jensen
3486 P. polychromogenes (Vallee) H. L. Jensen
Proteus Hauser. See Bacterium
2875 Protaminobacter albo-flavum α den Dooren de Jong
2876 P. albo-flavum β den Dooren de Jong
2877 P. albo-flavum γ den Dooren de Jong
2878 P. albo-flavum δ den Dooren de Jong
2879 P. rubrum den Dooren de Jong
3151 Prototheca portoricensis Cif. & Ashf.
3152 P. portoricensis Cif. & Ashf. var. trispora Cif. & Ashf.
Pseudomonas Migula. See Bacterium
499 Pseudosaccharomyces africanus Klöck.
490 P. antillarum Klöck.
497 P. apiculatus (Hansen) Reess
492 P. austriacus Klöck.
485 P. corticis Klöck.
491 P. germanicus Klöck.
487 P. indicus Klöck.
498 P. javanicus Klöck.
494 P. Jensenii Klöck.
489 P. Lafarii Klöck.
1816 P. Lindneri Klöck.
484 P. malaianus Klöck.
496 P. Muelleri Klöck.
486 P. occidentalis Klöck.
493 P. santacruzensis Klöck.
488 P. Willii Klöck.
1745 Pullularia nigrans Berkh.
1547 P. pullulans (de Bary & Löw) Berkh.
3317 Pyronema confluens Tul.
3053 P. domesticum (Sow.) Sacc.
3048 Pythium acanthicum Drechs.
3546 P. anandrum Drechs.
3328 P. aphanidermatum (Eds.) Fitz.
2810 P. complectens Braun
2467 P. de Baryanum Hesse
3557 P. graminicola Subram.
3545 P. helicoides Drechs.
3549 P. intermedium de Bary
3232 P. irregulare Buis.
3547 P. periplocum Drechs.
2652 P. splendens Braun
4408 Radulum quercinum Fr., F.P.R.L.
4096 Rhacodium cellare Pers.
Rhinocladium. See Sporotrichum
Rhizobium Frank. See Bacterium
Rhizoctonia bataticola. See Macrophomina Phaseoli
1175 R. destruens Tassi
R. lamellifera Small. See Macrophomina Phaseoli
1464 R. Solani Kühn
2097 R. Tuliparum (Kleb.) Whetzel
1905 Rhizopus japonicus Vuill.
3108 R. nigricans (+) Ehrenb.
2419 R. nigricans (−) Ehrenb.
1907 R. Oryzae Went & Geer.
1906 R. tonkinensis Vuill.
2466 R. Tritici Saito
907 Rhodotorula plicata Harrison
241A R. rutila Harrison
4409 Rosellinia arcuata Petch, F.P.R.L.
2526 Sabouraudites Audouinii (Gruby) Ota & Langer.
2524 S. felineus (Fox & Blaxall) Ota & Langer.
2525 S. lanosus (Sabour.) Ota & Langer.
3864 Saccharomyces anamensis Will & Heinrich
S. apiculatus. See Pseudosaccharomyces
3597 S. Blanchardii (Blanchard) Guiart
1808 S. brasilensis Lindn.
742 S. carlsbergensis Hansen
3865 S. cartilaginosus Lindn.
815 S. cereviseae Hansen (Baking yeast)

2160 S. cereviseae Hansen (Brewing yeast)
2779 S. cereviseae Hansen (Distilling yeast)
2054 S. Chevalieri Guill.
3964 S. Delbrueckii
467 S. ellipsoideus Hansen
3866 S. ellipsoideus Hansen var. cratericus
812 S. exiguus (Reess) Hansen
3139 S. festinans Ward & Baker
905 S. fragilis Jörgensen
1681 S. Hansenii Zopf
1809 S. Ilicis Grönlund
469 S. intermedius Hansen
2053 S. Lindneri Guill.
472 S. Marxianus Hansen
743 S. monacensis Hansen
2049 S. muentzii (Kayser) Naganishi
468 S. Pastorianus Hansen
S. Pastorianus II. See S. intermedius
S. Pastorianus III. See S. validus
1071 S. piriformis Marshall Ward
1015 S. sake Yabe
790 S. thermantitonum Johnson
4203 S. turbidans Hansen
470 S. validus Hansen
2404 S. sp. from Californian wine
1879 S. sp. (Cider yeast)
3859 S. sp. (Fernbach 1)
3860 S. sp. (Fernbach 33)
3861 S. sp. (Fernbach 38)
3862 S. sp. (Fernbach 40)
3863 S. sp. (Fernbach 41)
903 S. sp. (Frohberg yeast)
3965 S. sp. (Hill's yeast)
1806 S. sp. (Yeast: Johannesberg II) Wortmann
904 S. sp. (Kefir yeast) Hansen
607 S. sp. (Yeast: lactose-fermenting)
909 S. sp. (Logos yeast)
1639 S. sp. (Mahua yeast)
1467 S. sp. (Mineral yeast, "Futterhefe")
1346 S. sp. (Pink yeast)
3966 S. sp. (Race V)
2074 S. sp. (Rasse II)
2031 S. sp. (Rasse XII)
906 S. sp. (Saaz yeast)
608 S. sp. (Sternberg yeast, "675")
473 Saccharomycodes Ludwigii Hansen
814 Saccharomycopsis capsularis Schiönn.
3503 Saprolegnia sp.
952 Sarcina aurantiaca Flügge
3868 S. flava de Bary
3967 S. gasoformans Gruber
611 S. lutea Flügge
2768 Scedosporium apiospermum Sacc. (human pathogen)
4410 Schizophyllum commune Fr., F.P.R.L.
1014 Schizosaccharomyces mellacei Jörg.
382 S. octosporus Beij.
902 S. Pombe Lindn.
476 Schwanniomyces occidentalis Klöck.
1073 Sclerotinia cinerea Schr.
1238 S. cinerea Schr. forma Mali Wormald
1239 S. cinerea Schr. forma Pruni Wormald
2198 S. erythronii Whetzel
1072 S. fructigena (Pers.) Schr.
3342 S. intermedia Ramsay
3343 S. minor Jagger
1074 S. sclerotiorum (Lib.) Bref.
3344 S. trifoliorum Erikss.
1076 Sclerotium cepivorum Berhk.
2516 S. fulvum Fr.
2714 S. Gladioli Massey
1262 S. Rolfsii Sacc.
1497 S. Tuliparum Kleb.
2965 Scolecobasidium constrictum Abbott
580 Scopulariopsis brevicaulis (Sacc.) Bain.
581 S. brevicaulis (Sacc.) Bain. var. alba Thom
3171 S. sp. from Bullfrog
3867 S. sp. from Numbskull toad
1891 Septoria Lycopersici Speg.
1594 S. Tritici Desm.
Serratia Bizio. See Bacterium
3318 Sordaria fimicola (Rab.) Ces. & de Not.
3319 S. sp. Wilkins
4072 S. sp. R.C.
2864 Sphaeropsis malorum Peck
3068 Sphaerostilbe aurantiaca Tub.
1860 Spicaria javanica Bally
2229 S. prasina (Maubl.)
953 Spirillum rubrum v. Esmarch
1750 Spirochaeta cytophaga Hutch.
2959 Spondylocladium xylogenum A. L. Smith
3533 Sporendonema casei Desm.
4179 Sporidinia grandis Link
3770 Sporodesmium Bakeri Syd.
3017 Sporotrichum Beurmannii Matr. & Ram.
4075 S. bombycinum (Corda) Rab.
4074 S. carneolum

1672 S. carnis Brooks & Hansford
4157 S. Carougeauii Langer.
3020 S. equinum
3019 S. Gougerotii Matr.
406 S. Schenkii Perkins
193 Staphylococcus cereus-flavus Passet
963 S. cremoris-viscosi Hammer & Cordes
3769 Stemphylium macrosporoideum (B. & Br.) Sacc.
1005 S. sp. from cotton canvas
1455 S. sp. from soil
4411 Stereum fasciatum (Schw.) Fr., F.P.R.L.
4412 S. hirsutum Fr., F.P.R.L.
4413 S. purpureum Fr., F.P.R.L.
4414 S. rugosum (Pers.), F.P.R.L.
4415 S. sanguinolentum (Alb. & Schw.) F.P.R.L.
4416 S. spadiceum Fr., F.P.R.L.
4417 S. spadiceum Fr. var. quercinum Fr., F.P.R.L.
Sterigmatocystis Cramer. See Aspergillus
3253 Streptobacterium casei Orla-Jensen
4125 S. plantarum Orla-Jensen
662 Streptococcus acidi-lactici Grot.
2371 S. apis Maassen
2701 S. bovis Orla-Jensen
S. citrovorus. See Leuconostoc citrovorum
2702 S. glycerinaceus Orla-Jensen
2705 S. liquefaciens Orla-Jensen
S. paracitrovorus. See Leuconostoc dextranicum
Streptothrix Cohn. See Actinomyces
1129 Stysanus Stemonites (Pers.) Corda
4097 S. sp., R.C.
3155 Syncephalastrum cinereum Bain.
2699 Tetracoccus casei Orla-Jensen
2672 Thamnidium chaetocladioides Bref.
1127 T. elegans Link
3320 Thielavia basicola (B. & Br.) Zopf
1223 Thielaviopsis ethaceticus Went
1260 T. paradoxa (de Seynes) v. Höhn
3135 Thiobacillus thiooxidans Waks. & Joffe
Timothy grass bacillus. See Mycobacterium Phlei
2630 Torula aclotina Kufferath
2635 T. aerius Saito
2639 T. alactosa Kluyver
2638A T. aurantiaca Saito
2647 T. aurea Saito
4146 T. botryoides Brooks & Hansford
2052 T. colliculosa Hartmann
1134 T. convoluta Harz
2625 T. corallina Saito
1302 T. cremoris Hammer & Cordes
4481 T. dattila Kluyver
2626 T. fermentati Saito
2643 T. flava Saito
1746 T. fuliginea Berkh.
2640 T. galactosa Kluyver
2648 T. glutinis (Cohn) Pringsheim & Bilewsky
2634 T. Gropengiesseri Harrison
2636 T. heveanensis Groenwege
T. histolytica. See Cryptococcus
2645 T. Holmii Jörg.
2637 T. lactosa Kluyver
1847 T. Laurentii Kufferath
2646 T. lipofera den Dooren de Jong
2624 T. lipolytica Jacobsen
2623 T. mineralis Haydruck & Haehn
2644 T. minuta Saito
2622 T. mucilaginosa Jörg.
2632 T. pulcherrima Lindn.
820 T. rosea
2628 T. rubescens Saito
2627 T. rubra Saito
2649 T. rubra Schimon
2631 T. rufula Saito
2642A T. rugosa Saito
2629 T. sanguinea Schimon
1303 T. sphaerica Hammer & Cordes
3576 T. utilis Henn.
T. spp. from man. See Cryptococcus
2046 Torulaspora fermentati Saito
2051 T. Roseii Guill.
3153 Torulopsis minuta (Saito) Cif. var. parvissima Cif. & Ashf.
3151 T. nitritophila Cif. & Ashf.
3369 Trachysphaera fructigena Tab. & Bunt.
4418 Trametes carnea Nees & Fr., F.P.R.L.
4419 T. gibbosa (Pers.) Fr., F.P.R.L.
4420 T. lilacino-gilva (Berk.), F.P.R.L.
4421 T. mollis (Sommerf.) Fr., F.P.R.L.
4422 T. odorata Wulf., F.P.R.L.
4423 T. pini (Brot.) Fr., F.P.R.L.
4424 T. protracta Fr., F.P.R.L.
4425 T. rubescens (A. & S.) Fr., F.P.R.L.
4426 T. serialis Fr., F.P.R.L.
4427 T. serpens Fr., F.P.R.L.
4428 T. suaveolens (Linn.) Fr.
3676 Trichoderma Koningi Oudem.
3883 T. lignorum (Tode) Harz
4076 T. sp., R.C.

4429 Tricholoma rutilans (Schaeff.) Fr., F.P.R.L.
2993 Trichophyton album Sabour.
T. acuminatum. See T. Sabouraudii
3002 T. asteroides Sabour.
704 T. balcaneum Cast.
3000 T. cerebriforme Sabour.
2784 T. decalvans Cast.
3004 T. depressum MacCarthy
2995 T. discoides Sabour.
2992 T. effractum Sabour.
2996 T. equinum Matr. & Dassonv.
2997 T. fumatum Sabour.
2991 T. glabrum Sabour.
3003 T. granulosum Sabour.
3001 T. lacticola Sabour.
2786 T. louisianicum Cast.
2785 T. nodoformans Cast.
2994 T. ochraceus Sabour.
2998 T. persicolor Sabour.
2999 T. plicatile Sabour.
2521 T. Sabouraudii R. Blanchard
2522 T. sulphureum Fox
2520 T. tonsurans Malmsten
3367 Trichosporium Pedrosoi (Brumpt) Langer. (human pathogen)
3589 Trichosporum Beigeli Rabenh.
T. rugosum. See Hemispora
Tyrothrix Duclaux. See Bacillus
Unterhefe I. See Saccharomyces carlsbergensis
Unterhefe II. See S. monacensis
4073 Ustilago Avenae (Pers.) Jensen
3878 U. Carbo DC.
2211 U. Zeae Beck
4430 Ustulina vulgaris Fr., F.P.R.L.
4431 U. zonata (Schaeff.) Fr., F.P.R.L.
3387 Venturia chlorospora (Ces.) Karst.
2363 V. inaequalis Aderh.
1180 V. pirina Aderh.
2508 Vermicularia Dematium (Pers.) Fr.
2506 V. Eryngii Corda
2507 V. trichella Fr.
2512 Verticillium albo-atrum Reinke & Berth.
V. cinnabarinum. See Acrostalagmus
4475 V. ochro-rubrum Desm.
2583 Vibrio cuneata Gray & Thorn.
2581 V. cyclosites Gray & Thorn.
2582 V. neocistes Gray & Thorn.
1937 V. percolans Mudd & Warren
4432 Volvaria bombycina (Schaeff.) Fr., F.P.R.L.
1670 Wardomyces anomala Brooks & Hansford
474 Willia anomala Hansen
1546 W. belgica Lindn.
3596 W. margaretae (Zender) Guill.
475 W. Saturnus Klöck.
4433 Xylaria hypoxylon (L.) Grev., F.P.R.L.
4434 X. polymorpha (Pers.) Grev., F.P.R.L.
Yeast spp. See Saccharomyces
Zopfius Wenner & Rettger. See Bacterium
813 Zygosaccharomyces Barkeri Sacc. & Syd.
2047 Z. bisporus Naganishi
2057 Z. Nadsonii Guill.
2058 Z. Pastori Guill.
4464 Z. Priorianus Klöck.
1813 Z. sp. from fig (Carlsberg Collection)
1814 Z. sp. from honey (Carlsberg Collection)

## REFERENCES

(1) St John-Brooks, R. and Rhodes, M. "A list of fungi, etc., maintained in the National Collection of Type Cultures." *Trans. Brit. mycol. Soc.* xv (1930), 155–63.
(2) Raistrick, H. *et al.* "Studies in the biochemistry of micro-organisms." *Philos. Trans.* B, *Roy. Soc.* ccxx (1931), 1–367.
(3) *Catalogue of the National Collection of Type Cultures maintained at the Lister Institute of Preventive Medicine.* Medical Research Council, Special Report Series, No. 64 (revised). London: His Majesty's Stationery Office, 1931.
(4) "The genus *Salmonella* Lignières, 1900." Issued by the Salmonella Subcommittee of the Nomenclature Committee of the International Society for Microbiology." *J. Hyg.*, Camb. xxxiv (1935), 330–50.

# A NEW SPECIES OF *GLOMERELLA* ON *CAMELLIA THEAE*

By A. C. TUNSTALL
(*Mycologist, Indian Tea Association*)

(With Plate XV and 1 Text-figure)

The leaves of the tea plant are very commonly attacked by *Colletotrichum Camelliae*. The perfect form of this fungus—*Glomerella cingulata*—is also frequently present on the same leaves in north-east India. As a general rule the attacks of this fungus are confined to the leaves on which they cause a disease called brown blight. Occasionally it is found on the green internodes and less frequently on young red wood. During an investigation of the diseases of woody branches, a fungus was very frequently isolated from apparently sound wood in the vicinity of rotting lesions. This fungus was at first confused with *G. cingulata*, but further investigation showed that it was distinct. Although the form of the fructifications of both the *Colletotrichum* and the *Glomerella* type closely resembled that of *G. cingulata*, the dimensions were consistently larger. At first this was considered to be the effect of environment, but subsequent investigation showed that even when grown in the same environment for three generations the two fungi remained distinct. The new fungus was then given the name *Glomerella major*.

***Glomerella major*** sp.nov.

*Mycelium* colourless at first, changing with age to very dark brown. *Colletotrichum form:*

*Conidia*, mean $24{\cdot}8 \times 7{\cdot}7\mu$, range $14{\cdot}4$–$30{\cdot}6 \times 4{\cdot}8$–$9{\cdot}6\mu$. 1–3 septate at germination, mostly cylindric with rounded ends, occasionally slightly curved; rarely attenuate at one end; finely granular contents; clear spot sometimes present at or near the middle.

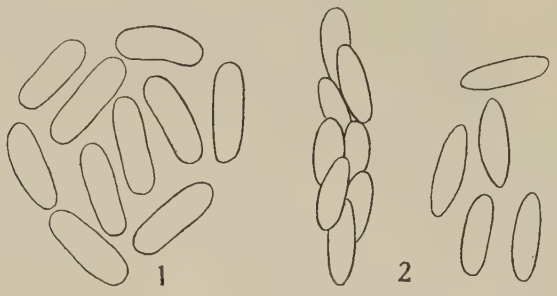
*Conidiophores* simple, or branched with brown walls; 2–3 septate; clavate; about double the length of the spores; apical enlarged cell 6–$8{\cdot}5\mu$ in diameter. Setae $100$–$200 \times 4{\cdot}5$–$5\mu$; brown to opaque-brown; up to 4 septate; subacute, or uniform tint.

*Glomerella form:*

*Perithecia* very variable; diameter 130–$150\mu$; beaked ostioles commonly present with or without an apical tuft of brown hairs, sometimes spinose, dotted or warted; beaks, when present, cylindric or subconical, up to $160 \times 100\mu$. Opaque black walls up to $50\mu$;

developed in a stroma beneath periderm, either remaining immersed or becoming erumpent with beaked ostiole.

*Asci* clearly defined only when immature; when mature about 70–110 × 10–18$\mu$; paraphyses not present.




Text-fig. 1. *Glomerella major*. 1, conidiospores, × 500; 2, ascospores, × 500.

*Ascospores* usually 8 in ascus; elliptic with obtuse or subacute tips; frequently slightly inequilateral; not allantoid; clear spot at the middle; mean 24·9 × 7$\mu$, range 15·6–30·1 × 5·5–8·4$\mu$; walls usually become brown when released into perithecial cavity; germination sometimes occurs in the cavity, the spores becoming 1–2 septate, rarely 3 septate.*

## Comparison with *Glomerella cingulata* (Stonem.) Spauld. & von Schr.

Apart from the dimensions the above description may apply to *G. cingulata*. It is therefore very important to determine the size of the spores with accuracy.

**Glomerella major* sp.nov.

Mycelium primum hyalinum, deinde senectute valde fuscum.

*forma Colletotrichoides:*

*Conidiis* circa 24·8 × 7·7$\mu$ (variantibus 14·4–30·6 × 4·8–9·6$\mu$), 1–3 septatis, plerumque cylindricis utrinque rotundatis, subinde curvulis, raro ad apicem unum attenuatis; intus minute granulosis, in medio guttulâ hyalinâ aliquando praebitis.

*Conidiophoris* simplicibus ramosisve fuscis, 2–3-septatis, clavatis, quam sporis bis longioribus; cellulâ dilatatâ apicali 6–8·5$\mu$ diam.; setis 100–200 × 4·5–5$\mu$ fuscis vel opaco-fuscis, usque ad quater septatis, subacutis, unicoloribus.

*forma Glomerelloides:*

*Peritheciis* maxime varieformibus, 190–150$\mu$ diam., plerumque osteola rostrata saepe fasciculo pilorum fuscorum ornata, tum spinosa, tum punctata sive verrucosa, gerentibus; nostris cylindricis subconicisve, usque ad 160 × 100$\mu$; perithecii integumento opaco nigro usque ad 50$\mu$, in stromate infra periderma evoluto, aut semper immerso aut erumpente et osteolum rostratum gerente.

*Ascis* solum in immaturitate distinctis, in maturitate *c.* 70–110 × 10–18$\mu$, paraphysibus nullis; *ascosporis* plerumque octonis, ellipticis, obtusis subacutisve, saepe aliquanto inequilateralibus haud allantoideis; in medis guttula hyalina praebitis, *c.* 24·9 × 7$\mu$ (variantibus 15·6–30·1 × 5·5–8·4$\mu$), ad maturitatem fuscis; nonnunquam intra perithecii cavitatem germinantibus, 1–2 raro 3 septa evolventibus.

For this purpose material was obtained from eight different sources embracing all the tea areas in north-east India. Of each type not less than a hundred spores taken at random were measured. The results are shown in microns in the following table.

| | Length | | Breadth | |
|---|---|---|---|---|
| | Arithmetic mean | Standard error | Arithmetic mean | Standard error |
| Ascospores: | | | | |
| *G. major* | 24·9 | 0·18 | 7·0 | 0·05 |
| *G. cingulata* | 14·4 | 0·16 | 4·4 | 0·08 |
| Difference | 10·5 | ±0·24 | 2·6 | ±0·99 |
| Conidiospores: | | | | |
| *G. major* | 24·8 | 0·19 | 7·7 | 0·04 |
| *G. cingulata* | 15·4 | 0·18 | 4·7 | 0·04 |
| Difference | 9·4 | ±0·26 | 3·0 | ±0·05 |

It is clear from the above that the differences in dimensions are significant.

There are other differences which are not so definite. *G. major* has a more marked tendency, especially in culture, to produce long beaks on the perithecia. Both fungi produce hairs round the beaks of the perithecia when grown in very humid conditions but *Glomerella major* tends to produce relatively longer hairs.

The setae on the *Colletotrichum* form of both fungi are more numerous, and longer, under humid conditions. In *Glomerella cingulata*, setae were sometimes absent from the conidial acervuli but pure cultures made from them developed setae.

It is probable that the development of setae on the acervuli and hairs on the perithecia in both *G. cingulata* and *G. major* are influenced considerably by the atmospheric conditions; the development of the beak on the perithecia may be influenced similarly. As these characters are variable, the dimensions recorded should be accepted with caution.

The emergence of the perithecia of *G. major* from the substrata is also influenced by conditions of growth. In the field, the perithecia tend to remain immersed in the bark, while in a damp chamber it is not uncommon to find them growing freely on the surface.

It has been observed that hyaline ascospores squeezed out of a perithecium will germinate readily in water, producing not more than one septum, and without darkening in colour. On the host tissue however, the spores become darker and frequently form more than one septum when germinating. *G. cingulata* behaves similarly.

Both conidia and ascospores produce appressoria, which in culture on corn meal agar may be formed in long chains. In the field the appressoria are generally isolated, rarely two or three together. Once, however, masses of chains similar to those produced in culture were

observed on tea branches in the field. *G. cingulata* has not been seen to produce chains of appressoria even in culture.

Both the conidial and the perithecial forms have been produced from single spore cultures of either form and there is no evidence of heterothallism. *G. cingulata* does not form perithecia readily from single spore cultures.

### The occurrence of *Glomerella major*

Specimens of branches which had failed to produce new growth after pruning were selected at random from a number of plots situated on a tea garden in the Dooars. They were each divided into two portions, separating the one-year from the two-year-old wood. The portions were flamed and placed in separate sterile tubes with a little sterile water. In most of the branches the one-year-old wood was dead, while the two-year-old wood was alive at the time of collection. The collection was made from three series each containing six plots, and was continued for forty weeks. The tubes were examined from time to time during a period of four months subsequently.

More than thirty distinct organisms were found on the branches examined. Apart from the common moulds, such as *Penicillium*, *Glomerella major* was the most common fungus present on both the living and dead portions of the twigs. *G. cingulata* was not found. *G. major* appears to be able to attack both dead and living tissues with equal facility. The infection was evidently greater in the latter part of the season.

The following table summarises the observations made.

*Glomerella major*

| Periods of five weeks commencing March 7th | Stems bearing either or both forms | | | Percentage of total infected portions bearing | |
|---|---|---|---|---|---|
| | Top portion max.=90 | Bottom portion max.=90 | Total max. =180 | Perithecial form | Conidial form |
| March–April | 38 | 30 | 68 | 83 | 45 |
| April–May | 19 | 20 | 39 | 64 | 53 |
| May–June | 29 | 35 | 64 | 57 | 57 |
| June–July | 33 | 30 | 63 | 19 | 98 |
| July–Aug. | 31 | 32 | 63 | 11 | 98 |
| Aug.–Sept. | 48 | 63 | 111 | 43 | 94 |
| Oct. | 49 | 48 | 97 | 81 | 87 |
| Nov. | 50 | 51 | 101 | 98 | 47 |

The occurrence of the two forms showed marked differences at different periods of the year. The conidiospores were produced most frequently on stems collected in the rainy season, while the perithecial form was markedly less at this season. It is interesting to note that the conidiospores have sticky coats and are thus readily distributed by insects, etc., while the ascospores are more suitable for distribution by

the wind. It is suggestive that the sticky spores are produced most freely at the time of the year when insects are most prevalent. The behaviour of *G. cingulata*, the Brown Blight fungus, is very similar in this respect.

At the end of the period during which the observations were made, ten apparently healthy branches were taken from each of the plots when pruning, two branches from each group of tea being taken at random and in two portions. One portion was taken immediately above the pruning cut, *i.e.* to one-year-old wood and the other from the green stems immediately above the wood. The stems were flamed and placed in sterile tubes as before and examined three months later. In these branches the bottom portions corresponded to the top portion of the moribund ones (see preceding table), none of which bore any green wood. In the following table the moribund twigs received during the five weeks preceding the collection of the healthy ones are compared with the latter.

*Percentage of tubes infected*

| Description | *G. major* | *G. cingulata* |
|---|---|---|
| Moribund twigs. Top portion | 56 | 0 |
| Apparently healthy prunings. Bottom portion (corresponding to top portion of moribund twigs) | 10 | 0 |
| Green portion (not present on moribund twigs) | 20 | 13 |

It would appear that *G. major* is able to attack both woody and green tissues, while *G. cingulata* seems to be confined to the green tissues.

It is interesting that apparently healthy prunings, from plots which had been sprayed twice with lime sulphur solution, produced no *G. major* on their green portions, while the spraying appeared to have had no effect at all in lessening the percentage of infection on the woody portions. It seemed possible that the infection of the green portions was mostly superficial so that they were exposed to the action of the fungicide while the fungus was within the tissues of the woody portions. This supposition was confirmed by microscopic examination.

### The association of *Glomerella major* with disease

The dying back of branches after pruning is not necessarily due to the presence of parasitic organisms. Dry winds and lack of reserves in the plant have been found to exercise a marked influence. If, however, a dead branch is allowed to remain on the plant it frequently starts a rotting hole. The actual rotting is usually associated with the presence of Basidiomycetes, such as *Poria hypobrunnea*. In the microscopic examination of the specimens mentioned above—more than

1500—no mycelium resembling that of a Basidiomycete was observed.

In another experiment, bearing on the treatment of pruning cuts, 240 large cuts were examined microscopically, as well as in culture, one year after they were made, and no Basidiomycetes were found. It was not until the second year after cutting that fungi of that group were detected.

On the other hand large numbers of rotting snags have been examined from all the tea districts in north-east India, and almost invariably it has been found possible to isolate *Glomerella major* from the apparently sound tissues adjacent to the rotting ones. No other fungus has been found so consistently.

As the parasite is present frequently in apparently healthy branches it is evident that vigorous plants exhibit a considerable degree of resistance to injury from its attack. *G. cingulata* seems to behave similarly. The latter fungus may be found on most tea bushes in north-east India but it causes noticeable injury only to tea plants weakened by other causes.

The writer wishes to acknowledge with many thanks the help of the Imperial Mycological Institute in examining and reporting on slides and specimens in connection with this investigation. He desires also to thank Mr E. W. Mason for drawings of the conidiospores and ascospores from the slides.

A perithecium of *Glomerella cingulata* on tea leaf reproduced on the same scale as that of *G. major* to show difference in size.



A perithecium of *Glomerella major* on tea stem.

# THE PRESENCE AND ABSENCE OF AN ENDOPHYTIC FUNGUS IN *LOLIUM TEMULENTUM* AND *L. PERENNE*

By KATHLEEN SAMPSON, M.Sc.
(*University College of Wales, Aberystwyth*)

## I. Introduction

Interest in the endophytic fungus of *Lolium* dates back to 1898 when Vogl recorded mycelium in the seed of *L. temulentum*. This was confirmed in the same year by Guérin (4), Hanausek (5) and Nestler (10), and in 1902 Neubauer and Remer added *L. remotum* to the list of species infected. Poisonous properties were already attributed to Darnel, and the idea that its toxicity might be linked with the fungus invading the seed added to the interest in its discovery, but such a connection has never yet been substantiated.

The best description of the progress of mycelium in the young ovule, the fruit and the embryo, is that of Freeman (3). He worked for the most part with *L. temulentum* and incidentally expressed his belief in the existence of strains lacking the fungus which could, he thought, be distinguished from infected grains by colour, but the possibility that the samples contained mixed types of the grass was not considered in this connection.

Hannig (6), who followed the transmission of the fungus through four generations of *L. temulentum*, found that fungus-free lines grown in open ground suffered no new infection, while invaded plants usually gave infected seed. Rarely a single grain in the infected series might miss the mycelium and form the starting point for a fungus-free population. Hannig states that in his cultures fungus-free fruits could be recognised only by microscopic examination.

Miss McLennan (8) made a detailed study of the invasion of *L. perenne*, and came to the conclusion that all plants of this species carry the endophytic fungus. She also differed from all previous authors in finding intracellular mycelium, but a careful study of her figures throws some doubt on this point.

A second paper by the same author (9) dealt with a fungus invading the roots of *L. perenne*. The organism described possesses non-septate intracellular mycelium with the sporangioles, vesicles, and more rarely arbuscles, characteristic of mycelia recorded in the roots of higher plants by other authors (12, 13, 16, 17). McLennan admits the absence of proof regarding the identity of this fungus with that found in the seed of *Lolium* sp., but the unfortunate title of the second paper

and a parallel drawn between the invasion of the grass and that of *Calluna vulgaris* by *Phoma radicis* (14) has led subsequent writers to accept the view that *L. perenne* is invariably associated with a Phycomycete which invades both the root and the shoot systems, and is transmitted by the seed (1, 2). Since a preliminary examination failed to substantiate this, experiments were initiated with the object of collecting further data on the relationship between *Lolium* spp. and the fungus often found in their fruits.

## II. Free and infected populations of *L. temulentum*

In 1929, with the kind assistance of Mr F. G. Preston, Superintendent of the Cambridge Botanic Garden, twenty packets of seed of *L. temulentum* were obtained from different Botanic Gardens in Europe. Microscopic examination of several fruits from each packet indicated that the samples could be classified on the presence or absence of mycelium as positive, negative or mixed. The number of samples containing infected fruits was larger than the number recorded as negative, indicating, as previous reports suggest, that the fungus-infected races of Darnel are widely distributed. These samples, sown in 1929 and 1930, formed the starting point of lines upon which the following observations were made.

At an early stage in the work an attempt was made to trace the mycelium back from the ovary to the base of the floral axis. This proved to be an unexpectedly easy task, since the mycelium is very abundant in the pith and persists there until maturity. It can be found without much difficulty even in fragments of pith taken from dry stems after harvest. To scrape the pith from a flowering stem, stain with cotton blue and examine under the microscope occupies from five to seven minutes, and this method has been used extensively in recording the presence and absence of mycelium in the populations of plants kept under observation. The results obtained have been confirmed from time to time by microtomed preparations of ovaries at different stages of growth and by hand sections of mature seed. The staining methods used were those described in a paper dealing with *Epichloe typhina* (15). The most complete series of observations was made on eight lines, the parents of which were selected and classified in 1929. Of these, three carried the fungus and four were fungus-free.* The general procedure was to grow each season in open ground ten plants of each line and to examine, by the pith-scraping method, at least two spikes from each plant. The total number of stems examined in this experiment is given in Table I where the records made on separate lines have been pooled in each of the two series.

* The term "fungus-free" is used throughout the paper only to denote the absence of that type of septate mycelium which permeates the vegetative organs, forms a zone outside the aleurone layer and is transmitted by the seed.

Table I. *Presence and absence of mycelium in the flowering stems of* Lolium temulentum *grown for four generations as single plants*

| | Fungus present in 3 selected parents, 1929 Mycelium in flowering stems | | Fungus absent in 5 selected parents, 1929 Mycelium in flowering stems | |
|---|---|---|---|---|
| Year | Present | Absent | Present | Absent |
| 1930 | 66 | 17 | 1 ? | 90 |
| 1931 | 31 | 1 | 0 | 23 |
| 1932 | 26 | 0 | 2 ? | 85 |
| 1933 | 24 | 0 | 0 | 45 |
| Totals | 147 | 18 | 3 ? | 243 |

In the populations derived from infected parents, only eighteen out of 147 stems were recorded as negative. The probability is that the mycelium was either missed in removing the pith or overlooked by the observer, since seed from the plants thus recorded as negative showed characteristic mycelium in abundance.* In these experiments with Darnel I have found so far no example of a fungus-free plant originating from an infected parent. Such cases might reasonably be expected to occur at times and some were actually recorded in Hannig's cultures of *L. temulentum* (6) and in my own populations of *L. perenne* (p. 341).

In the families derived from five parents selected in 1929 as fungus-free, 243 stems were examined and three were recorded as containing mycelium. It is believed that the mycelium in these three stems belonged to another fungus, possibly *Helminthosporium* sp. since traces of stripe disease appeared on some of the plants. Certainly the seed derived from the plants thus recorded as positive showed no signs of mycelium and their descendants were likewise fungus-free. In so far as the *Lolium* endophyte is concerned, the infected and non-infected lines remained true for this character through five generations.

## III. Crosses between free and infected plants of *L. temulentum*

In the experiment just described the plants were grown in the open ground with no control of pollination. Since *L. temulentum* is highly self-fertile the probability is that self-pollination occurred almost exclusively. Microscopic observations on the distribution of the fungus in infected plants suggests that the fungus is normally carried only *via* the ovule. In confirmation of this, and in order to obtain additional evidence for the existence of fungus-free plants, reciprocal crosses were made between parent plants selected from the above experi-

* Another possibility is that a single inflorescence may sometimes miss infection. This could not be proved, as the seed examined was of necessity taken from another spike on the same plant.

ments. The technique of crossing was carried out entirely by Mr A. R. Beddows, M.Sc., whose help I gratefully acknowledge. Data collected from the first, second and third generations are summarised in Table II. The crosses were made in 1931 under carefully controlled conditions in a greenhouse, while $F_2$ and $F_3$ generations resulted from the natural self-pollination of $F_1$ and $F_2$ plants grown in the open.

Table II. *Crosses between free* (553) *and infected* (547) *plants of* L. temulentum

| Year | Parents | Cross. Female parent is first named | Generation No. | Seed | Plants |
|---|---|---|---|---|---|
| 1931 | 547+ | — | — | — | — |
| | 553− | — | — | — | — |
| 1932 | 547+ (20)* | 553 × 547 | $F_1$ | − (5) | − (16) |
| | 553− (26) | 547 × 553 | $F_1$ | + (5) | + (21) |
| 1933 | 547+ (10) | 553 × 547 | $F_2$ | − (5) | − (112) |
| | 553− (10) | 547 × 553 | $F_2$ | + (5) | + (95) |
| 1934 | 547+ (5) | 553 × 547 | $F_3$ | — | − (5) |
| | 553− (5) | 547 × 553 | $F_3$ | — | + (10) |

* Figures in brackets refer to the number of observations made. The results were consistent throughout the experiment. A plus sign (+) indicates the presence of mycelium; a minus sign (−) indicates its absence.

The fungus-free parent (553) is one which has now remained free from infection through six generations (1929–34), while parent 547 has been consistently infected over the same period. In reciprocal crosses only those seeds and plants were infected which had 547 as the female parent. $F_2$ and $F_3$ generations were consistently either infected or fungus-free, according to which parent plant functioned as the female in the original cross.

The two parents selected differed also somewhat markedly in certain vegetative characters, 553 being a multi-tillering leafy type, while 547 had rather few strongly developed stems. Observations on the segregates of each cross showed that the characteristics of the parent were in no way connected with the presence and absence of the fungus. It has been possible to select from the $F_3$ generation of cross 553 × 547 a plant which had the habit of 547 but lacked the fungus; in family 547 × 553 plants occurred which closely resembled 553, but were infected. Such results indicate the danger of making a comparison between infected and non-infected plants of *Lolium* sp. without recognition of their possible origin from different strains of the host species. The statement by Freeman (3) that infected plants of Darnel are more vigorous and more productive, and the result of Hannig (7) that they contain more nitrogen than fungus-free races, are possibly subject to this error.† Until we have obtained, by inocula-

† In a footnote to the fourth edition of his *Pflanzenphysiologie* Jost states that Hannig expressed verbally his doubt about nitrogen fixation by the *Lolium* endophyte.

tion, infected and non-infected individuals of the same strain of the host plant a comparison may be made using $F_1$ plants obtained from a reciprocal cross between an infected and a non-infected plant. The crosses discussed here were made with this object in view, and detailed observations and measurements have been made on single $F_1$ plants. The results will be presented when data are available from a second experiment dealing in a similar manner with *L. perenne*. Concerning *L. temulentum* the available facts indicate that the effect of the fungus on its host, whether for good or ill, is too small to be discernible either by eye observation or by any method of measurement adopted by me.

## IV. Free and infected populations of *L. perenne*

In 1929 a preliminary examination of wild and pedigree plants of *L. perenne* led me to conclude that an endophytic fungus is by no means universally present in this species. Three plants were finally selected for generation studies which have been carried on for six years. The details of procedure were essentially the same as for *L. temulentum*, except that the perennial character of the host made it possible to include observations on the over-wintering of mycelium in the tiller buds and its distribution in propagants.

In one of the selected parents the mycelium present stained only faintly with cotton blue, and it was distinctly less easy to detect in pith scrapings and in sections. After growing populations of this strain of the grass for several generations evidence appeared showing that it carried a fungus other than that usually indicated by the term *Lolium* endophyte. The details of this type of infection will be given in a future paper. Of the remaining plants one was fungus-free and the other carried what I believe to be the typical endophyte similar to that in *L. temulentum*. The data obtained are given in Table III.

Table III. *Free and infected populations of* L. perenne

| | Parent (1975) selected as fungus-free 1929 Mycelium in flowering stem | | Parent (1971) selected as infected 1929 Mycelium in flowering stem | |
|---|---|---|---|---|
| Year | Present | Absent | Present | Absent |
| 1931 progeny* | 0 | 21* | 26* | 2* |
| 1932 progeny | 0 | 22 | 55 | 1 |
| 1932 propagants | 0 | 20 | 20 | 0 |
| 1933 progeny | 0 | 40 | 36 | 11† |
| 1934 progeny | 0 | 20 | 20 | 10† |
| 1934 propagants | 0 | 6 | 6 | 6† |

* The figures for 1931 include a few observations made in 1930. In this year very few spikes were produced by the seedling plants. This difficulty was overcome in subsequent years by sowing soon after harvest.

† These figures include the progeny of a plant which missed infection in 1932. Data for every individual plant were always kept separate, but they are pooled in this table.

The behaviour of the plant-populations derived from the fungus-free parent (1975) can be dismissed briefly. No new infection occurred, both the progeny and the propagants remaining consistently free from invasion by the *Lolium* fungus. All the progeny examined from the infected plant (1971) carried the fungus in 1931–32, but in 1933 a single individual was noticed as having apparently escaped infection from its parent. The absence of the fungus was confirmed in both the progeny and the propagants of this plant in 1934 (Table III).

These experiments confirm the suspected existence of fungus-free races of *L. perenne* and indicate that they may arise from infected plants. We have as yet no knowledge as to how or when members of the genus *Lolium* became invaded by this fungus.

## V. Crosses between free and infected plants of *L. perenne*

The families of plants discussed in the preceding section were derived from spaced plants in garden soil with no control of pollination. Since *L. perenne* is a cross-pollinated species it is almost implicit in the results (Table III) that only the female organ carries the fungus. Confirmation of this was, however, obtained from certain hybrids and their parents which Dr T. J. Jenkin kindly allowed me to examine from the cultures of plants prepared for his genetical studies (Table IV).

Table IV. *Crosses between free and infected plants of* L. perenne *and* L. italicum

| Ref. to $F_1$ | Mycelium in $F_1$ | Female parent | Mycelium | Male parent | Mycelium |
|---|---|---|---|---|---|
| 1065 | Absent | *L. italicum* | Absent | *L. perenne* | Present |
| 1063 | Present | *L. perenne* | Present | *L. perenne* | Absent |
| 1159 | Absent | *L. perenne* | Absent | *L. perenne* | Present |

## VI. Summary

The study of a series of pedigree populations of single plants of *L. temulentum* and *L. perenne* extending through six seasons has shown that both species can exist either with or without an endophytic fungus.

This fungus, when it occurs, invades the leaves, stems and tiller buds, and in a perennial plant it is distributed by vegetative propagation. It does not appear to invade the roots and it is in my opinion distinct from the Phycomycete type which has been recorded in these and other grasses, and in plants not closely related.

The *Lolium* endophyte invades the ovule, and that it is mechanically inherited from the female parent only has been shown by the reciprocal crossing of free and infected plants.

While races free from infection may arise from infected individuals, the origin of the infected races themselves is still obscure.

The problems of chief interest, namely, the identity of the organism and the biological aspects of its connection with the grasses, still await solution. That the relation is not an obligate one so far as the higher plant is concerned emerges from the experimental work discussed in this paper.

ACKNOWLEDGMENTS

I am indebted to Mr E. L. Hughes, M.Sc., and to Mr P. T. Thomas, B.Sc., who gave valuable help as student assistants during several summer vacations, and to Mr J. W. Watkins for his careful supervision of cultural details.

I wish to thank most cordially Prof. R. G. Stapledon, C.B.E., M.A., for granting me full use of the facilities of the Welsh Plant Breeding Station.

## REFERENCES

(1) BARTON-WRIGHT, E. C. *Recent Advances in Botany* (1932).
(2) BROWN, R. "Nitrogen fixation by the endophyte of *Lolium*." *J. agric. Sci.* XXIII (1933), 527–40.
(3) FREEMAN, E. M. "The seed-fungus of *Lolium temulentum* L., the darnel." *Philos. Trans.* B, CXCVI (1903), 1–27.
(4) GUÉRIN, P. "Sur la présence d'un champignon dans l'Ivraie." *J. Bot.*, Paris, XII (1898), 384.
(5) HANAUSEK, T. F. "Vorläufige Mitteilung über den von A. Vogl in der Frucht von *Lolium temulentum* entdeckten Pilz." *Ber. dtsch. bot. Ges.* XVI (1898), 203–7.
(6) HANNIG, E. "Über pilzfreies *Lolium temulentum*." *Bot. Ztg.* LXV (1907), 25–38.
(7) —— "Die Bindung freien atmosphärischen Stickstoffs durch pilzhaltiges *Lolium temulentum*." *Ber. dtsch. bot. Ges.* XXVI*a* (1908), 238–46.
(8) MCLENNAN, ETHEL. "The endophytic fungus of *Lolium*. I." *Proc. roy. Soc. Vict.* XXXII (N.S.) (1920), 252–301.
(9) —— "The endophytic fungus of *Lolium*. II. The mycorrhiza on the roots of *Lolium temulentum*." *Ann. Bot.* XL (1926), 43–68.
(10) NESTLER, A. "Über einen in der Frucht von *L. temulentum* L. vorkommenden Pilz." *Ber. dtsch. bot. Ges.* XVI (1898), 207–14.
(11) NEUBAUER, H. und REMER, C. "Über die von A. Vogl entdeckte Pilzschicht in Loliumfrüchten." *Zbl. Bakt.* II, 9 (1902), 652–3.
(12) PEYRONEL, B. "Sulla normale presenza di micorize nel grano e in altre piante coltivate e spontanee." *Boll. Staz. Patol. veg.*, Roma, III (1922), 43–50.
(13) —— "Prime ricerche sulla micorize endotrofiche e sulla microflora radicicola delle fanerogame." *Riv. Biol.* V and VI (1924), 3.
(14) RAYNER, M. C. "Obligate symbiosis in *Calluna vulgaris*." *Ann. Bot.* XXIX (1915), 97.
(15) SAMPSON, KATHLEEN. "The systemic infection of grasses by *Epichloe typhina* (Pers.) Tul." *Trans. Brit. mycol. Soc.* XVIII (1933), 30–47.
(16) SCHLICHT, A. "Über neue Fälle von Symbiose der Pflanzenwurzeln mit Pilzen." *Ber. dtsch. bot. Ges.* VI (1888), 269–72.
(17) SCHRÖTER, C. *Das Pflanzenleben der Alpen.* Zurich, p. 305 (1908).
(18) VOGL, A. "Mehl und die anderen Mehlprodukte der Cerealien und Leguminosen." *Z. Nahrungsmittel-Untersuchung, Hygiene u. Warenkunde*, XII (1898), 25–9.

# PROCEEDINGS

## Meeting held at University College, London, November 17, 1934, Dr B. Barnes, President, in the Chair.

### W. M. Ware. Mushroom growing in the United States of America.

The cultivation of mushrooms is a great and specialised industry in the U.S.A.; it has been brought to a high state of perfection by the growers themselves and is assisted by some half-dozen scientists who are carrying out research and advisory work in the mycological, entomological and chemical problems connected with it.

During the month of May 1934, with a Travelling Fellowship granted by the Ministry of Agriculture and Fisheries, a visit was paid to some of the Eastern States of the U.S.A. and it was possible not only to see numerous growing "plants" (the largest of which has one million sq. ft. of bed surface) but also to confer with research workers.

As a result of the experience gained, it is possible to appreciate the differences between American and English methods. The most noticeable is that, with few exceptions, the American growers construct specially designed buildings of standard type and, by the adoption of the tier system, they make the fullest use of the space available. This method of growing mushrooms also provides the best opportunity for making fumigation effective. Of the 516 growers included in the Horticultural Census, 363 are to be found in the State of Pennsylvania. The cropping period is limited to winter and spring because, although cooling systems are sometimes installed, they are not capable of counteracting completely the very high temperatures from May to September. Stable manure is still used for making the compost for the beds; substitutes are being sought and some have given hopeful results but at the present time the growers are not advised to abandon the natural for the more artificial medium. Storage of manure for several months, in very large and much compressed piles, is a practice adopted in Pennsylvania and one which is not seen in England.

Canneries, devoted entirely to the mushroom crop, are attached to some growers' premises; they are each capable of dealing with from three and a half to six tons of mushrooms a day.

Pure-culture spawn of high quality is made by about a dozen of the larger growers and a great quantity is exported to England. The process of manufacture is a commercial secret, but it is possible to see that the laboratories and equipment are well designed and scrupulously clean.

Co-operation is exemplified by a Mushroom Growers' Association with a membership of over 300. The M.G.A. buildings are situated at Kennett Square, Pa., and though they are primarily for commercial purposes, it is noteworthy that they include laboratory accommodation and an experimental mushroom house.

The fungus diseases of the crop are the same as those met with in England but American mushroom beds are not invaded by *Xylaria vaporaria* or *Clitocybe dealbata*. A truffle, *Pseudobalsamia microspora*, not yet recorded in England, is causing apprehension not only on account of its invasion of mushroom beds but also because of its persistence for several years in houses where it has once obtained a footing.

### D. M. Cayley. Field Observations on, and Cultural Experiments with, Wild and Cultivated Forms of Edible Mushroom.

Examination of a number of grass roots from sods which had carried pilei of *Psalliota campestris* and *P. arvensis* showed that the roots of many different species of

grass are very generally infected with several different types of mycelia, one of which is believed to be *Psalliota*.

Artificial infections under sterile conditions of four different species of grass seedlings have shown that the two wild species, *P. campestris* and *P. arvensis*, can penetrate and live in the roots for some months without materially affecting the growth of the grass. Positive artificial infections of the same species of grass have also been obtained with the white and fuscous forms of cultivated mushrooms, provisionally called *P. hortensis*. The type of mycelial growth in the cells of the artificially infected host plant closely resembles that found in certain types of natural infection.

Both *P. campestris* and *P. arvensis* can form "fairy rings" on pastures. With *P. campestris*, the grass on the ring appears to benefit in some way by the presence of the fungus, the grass being a darker green and of more luxuriant growth. With *P. arvensis*, on the other hand, the growth of the grass is poor.

The spores of *P. campestris* will germinate in Knop solution, without previous treatment, in from ten to twenty-one days, but success mainly depends upon the condition of the pileus when the spore trace is taken. Successive spore traces from the same pileus, taken at intervals of from twelve to twenty-four hours, have shown that the first shed spores from an immature pileus do not germinate under artificial conditions. The best germination is obtained from fully expanded pilei when the gills are umber in colour. With due precautions, the spore traces from fully expanded clean pilei were found to be mostly free from contamination. Kept under dry conditions, the spores of *P. campestris* remain viable for about six months, those of *P. hortensis* rather longer. Attempts to germinate the spores of *P. arvensis* in Knop solution have failed, partly owing to lack of mature spores.

## W. J. Dowson. The Occurrence of *Aplanobacter Rathayi* in Britain.

There are three similar bacterial diseases of cereals and grasses in which the conspicuous symptom is the malformation of the inflorescence and the presence on it of a copious yellow bacterial slime. *Aplanobacter Rathayi* is known only in Europe and attacks *Dactylis glomerata; Aplanobacter Agropyri* occurs in the Western United States on *Agropyron Smithii*, and *Bacterium Tritici* is found on wheat in conjunction with eelworm, *Tylenchus tritici*, from Cyprus to Western Australia. Until recently *Aplanobacter Rathayi* had not been recorded definitely for Britain although suspected in Wales and Scotland; but in the summer of 1934 a large patch of Cocksfoot grass was found heavily infected on the bank of the river Cam, not far from Cambridge. When inoculated directly into young plants typical symptoms resulted; but pure cultures of the yellow organism failed to produce inoculation. In isolating this organism by the plate method two other bacteria were also found in the naturally occurring slime: one, a white gram positive form, the other a gram negative organism. E. F. Smith found much the same thing, as did also O'Gara with *A. Agropyri*, and the question arises as to which of the three organisms is the real parasite, in view of the fact that the gram positive yellow one in pure culture fails to produce infection. Possibly a combination of all three, or of any two, is necessary to bring about the typical symptoms of the disease. In the three diseases mentioned, at least two organisms are constantly and intimately associated, viz. a white, motile gram positive bacterium with the two species of Aplanobacter, and the eelworm, *Tylenchus tritici* with *Bacterium Tritici*.

## A. R. Wilson. Observations on the Occurrence of Bacterial Plant Diseases in the United States.

A comparison was made of the status of bacterial plant pathology in Great Britain and the United States. A brief account was then given of several bacterial diseases observed during the summer of 1934 in various parts of the United States, including a brief review of the Crown-Gall situation in that country. In conclusion

an account was given of a survey of the incidence of Fire Blight of apples in the State of Wisconsin, including a discussion of the influence of climatic factors on the occurrence of the disease, and the possible influence of these factors on an outbreak of the disease in Great Britain. A brief description was given of the methods adopted for the control of Fire Blight at the University Field Station at Gays Mills, Wisconsin.

Mrs M. d'Oliveira. Notes on *Bacterium Savastanoi.*

*Bacterium Savastanoi* and its variety *Fraxini* cause respectively the diseases known as olive knot and ash canker, the former occurring wherever the olive is grown; the latter only in Europe. Comparisons have been made hitherto in the United States by E. F. and C. O. Smith. The present account deals with similar work carried out at the Botany School, Cambridge. By numerous infection experiments on a range of hosts it was shown that (1) in this range of hosts there was none which could be infected by both organisms and (2) that the olive knot organism, *B. Savastanoi*, always produces knots or overgrowths as a result of infection, whereas the ash parasite, *B. Savastanoi* var. *Fraxini* always forms a canker-like lesion. Culturally, both organisms are similar, as E. F. Smith demonstrated: but in view of the different and constant pathological effects the designation of the ash organism as a variety only of the olive bacterium should be reconsidered. In south England the ash bacterial disease is often complicated by the presence of *Nectria* which alone or together with the bacterium produces an overgrowth.

# LIST OF MEMBERS

*Honorary Members*

Lister, Miss Gulielma, F.L.S., 871, High Road, Leytonstone, Essex. (1903.) (1924.)

Rea, Mr Carleton, B.C.L., M.A., 6, Barbourne Terrace, Worcester. (1896.) (1918.)

Smith, Miss Annie Lorrain, O.B.E., F.L.S., 44, Stanwick Mansions, Stanwick Road, London, W. 14. (1899.) (1924.)

*Ordinary Members*

1. Aberdeen, The University Library. (1916.)
2. Adams, Rev. J. H., Landulph Rectory, Hatt, Saltash, Cornwall. (1919.)
3. Adcock, Mr Archie, Upton Road, Norwich. (1921.)
4. Ainsworth, Mr G. C., B.Sc., Experimental and Research Station, Cheshunt, Herts. (1931.)
5. Ainsworth, Mrs G. C., B.Sc., D.I.C., 13, Turner's Hill, Cheshunt, Herts. (1932.)
6. Alcock, Mrs N. L., F.L.S., Royal Botanic Gardens, Edinburgh. (1919.)
7. Arney, Mr S. E., B.A. (Oxon.), Weacombe, Warren Lane, Aylesford, Kent. (1932.)
8. Ashby, Mr S. F., B.Sc., Imperial Mycological Institute, Ferry Lane, Kew, Surrey. (1926.)
9. Ashford, Dr Bailey K., Professor of Tropical Medicine and Mycology, University of Porto Rico, Box 887, San Juan, Porto Rico, W.I. (1929.)
10. Asthana, Mr R. P., Ph.D., M.Sc., D.I.C., F.L.S., c/o Mr Triloki Nath, District Judge, Meerut, U.P., India. (1932.)
11. Barnes, Mr B., D.Sc., Ph.D., F.L.S., Chelsea Polytechnic, London, S.W. 3. (1922.)
12. Barr, Rev. Robert, T.D., M.A., The Manse, Neilston, Renfrewshire. (1918).
13. Barrington, Dr F. J. F., University College Hospital, Medical School, University Street, London, W.C. 1. (1901.)
14. Bartlett, Mr A. W., M.A., M.Sc., F.L.S., Department of Botany, Armstrong College, Newcastle-on-Tyne. (1920.)
15. Bates, Mr G. R., c/o British South Africa Company, Mazoe Citrus Estate, Mazoe, S. Rhodesia. (1930.)
16. Bates, Mrs L. F., B.Sc., 36, Gainsborough Gardens, Golders Green, London, N.W. 11. (1921.)

17. Beardslee, Mr H. C., Perry, Ohio, U.S.A. (1933.)
18. Beaumont, Mr Albert, M.A., Seale-Hayne Agricultural College, Newton Abbot, Devon. (1924.)
19. Bellchambers, Mr A., The Gardens, Eaton Hall, Chester. (1932.)
20. Bewley, Mr W. F., D.Sc., Experimental and Research Station, Cheshunt, Herts. (1922.)
21. Biffen, Professor Sir Rowland H., M.A., F.R.S., 136, Huntingdon Road, Cambridge. (1899.)
22. Biologist, Plant Research Laboratory, Horticultural Gardens, Burnley, Victoria, Australia. (1921.)
23. Birmingham Natural History and Philosophical Society, c/o G. T. Calvert, Esq., Hon. Librarian, Avebury House, 55, Newhall Street, Birmingham. (1920).
24. Bisby, Mr Guy R., Ph.D., Manitoba Agricultural College, Winnipeg, Canada. (1921.)
25. Blackman, Professor V. H., M.A., F.R.S., Imperial College of Science, South Kensington, London, S.W. 7. (1900.)
26. Blackwell, Miss E. M., M.Sc., Botanical Department, Royal Holloway College, Englefield Green, Surrey. (1917.)
27. Blagden, Mr C. O., 46, Portland Road, Holland Park Avenue, London, W. 11. (1910.)
28. Bolas, Mr B. D., M.Sc., 20, Cambridge Gardens, Winchmore Hill, London, N. 21. (1924.)
29. Bonn, Germany, Institut für Pflanzenkrankheiten, Nuss-Allee 9. (1931.)
30. Borthwick, Professor A. W., O.B.E., D.Sc., Forestry Department, The University, Aberdeen. (1911.)
31. Boston, The Mycological Club, c/o Miss Jennie F. Conant, 26, Prospect Street, Melrose, Mass., U.S.A. (1926.)
32. Bradshaw, Mr F., M.A., D.Sc., Armstrong College, Newcastle-on-Tyne. (1928.)
33. Braid, Professor K. W., B.A., B.Sc., West of Scotland Agricultural College, 6, Blythswood Square, Glasgow. (1922.)
34. Brazier, Mr E., Ty'n-y-gongl, Love Lane, Stourbridge. (1921.)
35. Brenchley, Mr G. H., B.A., Clare College, Cambridge. (1925.)
36. Brett, Miss M., M.Sc., Ph.D., Northern Polytechnic, Holloway Road, London, N. 7. (1921.)
37. Briant, Mr A. K., B.A., Imperial College of Tropical Agriculture, St Augustine, Trinidad, B.W.I. (1927.)
38. Brierley, Professor W. B., D.Sc., F.R.A.I., F.L.S., Department of Agricultural Botany, The University, Reading. (1919.)
39. Brisbane, The Director, Bureau of Sugar Experiment Stations, Department of Agriculture and Stock, Queensland, Australia. (1930.)

40. British Museum, The Trustees of, Cromwell Road, South Kensington, London, S.W. 7. (1914.)
41. Briton-Jones, Professor H. R., D.Sc., Ph.D., D.I.C., A.R.C.S., Imperial College of Tropical Agriculture, St Augustine, Trinidad, B.W.I. (1923.)
42. Brooks, Mr F. T., M.A., F.R.S., F.L.S., The Botany School, Cambridge. (1907.)
43. Brown University, Library, East Side Station, Providence, R.I., U.S.A. (1920.)
44. Brown, Professor W., M.A., D.Sc., Imperial College of Science, South Kensington, London, S.W. 7. (1922.)
45. Bruxelles, Jardin Botanique de l'État, c/o M. P. van Aerdschot. (1911.)
46. Bryce, Mr G., D.Sc., Department of Agriculture, Ibadan, Nigeria, W. Africa. (1915.)
47. Buckley, Mr W. D., "Lynmouth", 2 Curzon Street, Slough. (1916.)
48. Buddin, Mr Walter, M.A., Laboratory of Plant Pathology, University of Reading, 7, Redlands Road, Reading. (1921.)
49. Buller, Professor A. H. R., D.Sc., Ph.D., F.R.S., University of Manitoba, Winnipeg, Canada. (1911.)
50. Bunting, Mr R. H., F.L.S., 3 Stanton Court, Weymouth. (1921).
51. Burgess, Mr R., M.Sc., "Olivet", London Road, Sherburn in Elmet, Yorks. (1928.)
52. Burr, Mr S., M.Sc., Department of Agriculture, The University, Leeds. (1924.)
53. Butler, Mr E. J., C.I.E., C.M.G., D.Sc., M.B., F.R.S., F.L.S., Imperial Mycological Institute, Ferry Lane, Kew, Surrey. (1920.)
54. Cairns, Mr Hugh, M.Ag., B.Sc., The Queen's University, Belfast, N. Ireland. (1932.)
55. Caldwell, Mr J., B.Sc., Ph.D., Rothamsted Experimental Station, Harpenden, Herts. (1932.)
56. Cambridge, The Botany School. (1920.)
57. Campbell, Mr A. H., B.Sc., Ph.D., Department of Botany, The University, Bristol. (1934.)
58. Carne, Mr W. M., F.L.S., University of Tasmania, P.O. Box 647*c*., Hobart, Tasmania, Australia. (1928.)
59. Carr, Professor J. W., M.A., F.L.S., Mapperley Edge, Private Road, Sherwood, Nottingham. (1896.)
60. Carrothers, Mr. E. N., 7, Fitzwilliam Street, Belfast, N. Ireland, (1925.)
61. Carter, Miss F. M., Ph.D., Botanical Department, The University, Edgbaston, Biringmham, 15. (1934.)

62. Cartwright, Mr K. St G., M.A., F.L.S., The Red House, Kingston Blount, Oxford. (1913.)
63. Castellani, Sir Aldo, M.D., 23 Harley Street, London, W. 1. (1922.)
64. Cayley, Miss Dorothy M., John Innes Horticultural Institution, Mostyn Road, Merton Park, London, S.W. 19. (1913.)
65. Charles, Miss Vera K., United States Department of Agriculture, Bureau of Plant Industry, Washington D.C., U.S.A. (1933.)
66. Chaudhuri, Mr H., M.Sc., Ph.D., University of the Punjab, Lahore, India. (1920.)
67. Cheal, Mr W. F., Gosmoor Lane, Elm, nr Wisbech, Cambs. (1927.)
68. Chesters, Mr C. G. C., Botanical Department, The University, Edgbaston, Birmingham. (1930.)
69. Chona, Mr B. L., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1929.)
70. Ciferri, Professor Dr R., Assistant Director, Laboratorio Crittogamico, Casella Postale 165, Pavia, Italy. (1926.)
71. Clapham, Mr A. R., M.A., Ph.D., Department of Botany, The University, Oxford. (1931.)
72. Cleland, Mr J. Burton, M.D., Professor of Pathology, University of Adelaide, South Australia. (1918.)
73. Clouston, Mr D., M.A., B.Sc. (Agr.), North of Scotland College of Agriculture, Crown Mansions, 41, Union Street (2nd Floor), Aberdeen. (1931.)
74. Colston, Miss B., B.Sc., Ph.D., The University, Manchester. (1934.)
75. Connecticut Agricultural Experiment Station, New Haven, Connecticut, U.S.A. (1929).
76. Cook, Mr W. R. I., B.Sc., Ph.D., Department of Botany, University College, Newport Road, Cardiff. (1924.)
77. Cooke, Mr G. J., 143, Newmarket Road, Norwich. (1933.)
78. Cooper, Miss Charlotte A., California Lane, Bushey Heath, Herts. (1911.)
79. Cooper, Mrs V. Astley, Navestock, Horton Lane, Epsom, Surrey. (1921.)
80. Cornell University, The Library, New York State College of Agriculture, Ithaca, N.Y., U.S.A. (1920.)
81. Corner, Mr E. J. H., M.A., F.L.S., Assistant Director, Botanic Gardens, Singapore, Straits Settlements. (1924.)
82. Cotton, Mr Arthur D., O.B.E., F.L.S., Keeper, Herbarium, Royal Botanic Gardens, Kew, Surrey. (1902.)
83. Cunningham, Mr G. H., Ph.D., Plant Research Station, Box 442, Palmerston North, New Zealand. (1922.)

84. Curtis, Miss Kathleen M., M.A., D.Sc., D.I.C., F.L.S., Mycologist, Biological Department, Cawthron Institute of Scientific Research, Nelson, New Zealand. (1917.)
85. Cutting, Mr E. M., M.A., F.L.S., Botanical Department, University College, Gower Street, London, W.C. 1. (1920.)
86. Dade, Mr H. A., A.R.C.S., Department of Agriculture, Aburi, Gold Coast, West Africa. (1927.)
87. Das, Mr Kedarnath, C.I.E., M.D., Principal, Carmichael Medical College, 1, Belgachia Road, Calcutta, India. (1922.)
88. Davies, Mr D. W., B.Sc., Adviser in Mycology, Agricultural Buildings, University College of Wales, Aberystwyth. (1923).
89. Davis, Mr J. Jefferson, B.S., M.D., University of Wisconsin, Madison, Wis., U.S.A. (1921.)
90. Day, Mr W. R., B.A., B.Sc., Imperial Forestry Institute, Oxford. (1928.)
91. Deacon, Dr G. E., Brundall, Norwich. (1933.)
92. Dehra Dun, The Forest Botanist, Forest Research Institute and College, U.P., India. (1929.)
93. Deighton, Mr F. C., M.A., Mycologist, Department of Lands and Forests, Freetown, Sierra Leone, West Africa. (1925.)
94. Dennis, Mr R. W. G., Ph.D., West of Scotland Agricultural College, 6, Blythswood Square, Glasgow. (1932.)
95. Dickinson, Mr S., School of Agriculture, Cambridge. (1921.)
96. Dickson, Mr B. T., B.A., Ph.D., Senior Mycologist, Council for Scientific and Industrial Research, 314, Albert Street, East Melbourne, Australia. (1923.)
97. Dobbs, Mr C. G., B.Sc., Botanical Department, King's College, Strand, London, W.C. 2. (1933.)
98. Dobinson, Mr H., 166, Piccadilly, London, W. 1. (1932.)
99. Dodge, Dr Carroll W., Missouri Botanical Garden, 2315, Tower Grove Avenue, St Louis, Missouri, U.S.A. (1926.)
100. Dowson, Mr W. J., M.A., D.Sc., The Botany School, Cambridge. (1920.)
101. Duncan, Mr J. T., London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C. 1. (1930.)
102. Edwards, Mr W. H., Belle Vue, Barline, Beer, Devon. (1896.)
103. Elliott, Mr W. T., D.D.S., L.D.S., F.L.S., F.Z.S., Arden Grange, Tanworth-in-Arden, Warwickshire. (1913.)
104. Elliott, Mrs J. S. Bayliss, D.Sc. (B'ham), B.Sc. (Lond.), Arden Grange, Tanworth-in-Arden, Warwickshire. (1911.)
105. Ellis, Mr E. H., B.Sc., Gramarye, Farley Green, Guildford, Surrey. (1924.)
106. Ellis, Miss E. M., St Hugh's College, Oxford. (1930.)
107. Ellis, Mr Holmes, F.R.M.S., 108, Birtwistle Avenue, Colne, Lancs. (1927.)

108. Emoto, Dr Y., Biological Department, Peers' College (Gakushuin), Mejiromachi, Tokyo, Japan. (1929.)
109. Engledow, Professor F. L., M.A., School of Agriculture, Cambridge. (1922.)
110. Essex Field Club, c/o Mr Percy Thompson, F.L.S., Essex Museum of Natural History, Romford Road, Stratford, London, E. 15. (1919.)
111. Eweis, Mr E. M., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1932.)
112. Exeter, Librarian, University College of the South-West of England. (1926.)
113. Eyre, Miss J. C., c/o Miss Wakefield, Herbarium, Royal Botanic Gardens, Kew. (1915.)
114. Faulkner, Mr F., c/o Gillanders, Arbuthnot & Co., Bombay, India. (1930.)
115. Fenton, Mr E. W., M.A., B.Sc., F.L.S., Biology Department, Edinburgh and East of Scotland College of Agriculture, Edinburgh. (1920.)
116. Findlay, Mr W. P., B.Sc., A.R.C.S., Courte Falaise, Sevenoaks, Kent. (1928.)
117. Finlayson, Mr Raymond A., F.L.S., Official Seed Testing Station, Huntingdon Road, Cambridge. (1910.)
118. Fisher, Mr S. D. P., Sackville Street, Leeds. (1930.)
119. Forwood, Mr R., Minett, Muskoka, Ontario, Canada. (1930.)
120. Fountain, Mr A. S., F.R.M.S., 55, Moorgate, Rotherham, Yorks. (1934.)
121. Gadd, Mr C. H., D.Sc., Tea Research Institute, Nuwara Eliya, Ceylon. (1921.)
122. Galloway, Mr L. D., 2, Milton Crescent, Cheadle, Cheshire. (1928.)
123. Gardner, Capt. Frederic, c/o Barclays Bank, Jersey, C.I. (1898.)
124. Garside, Mr S., M.Sc., F.L.S., Botanical Department, Bedford College, Regent's Park, London, N.W. 1. (1922.)
125. Gates, Professor R. R., D.Sc., Ph.D., F.R.S., F.L.S., King's College, Strand, London, W.C. 2. (1921.)
126. Ghamrawy, Mr Ali K., 39 Monirah Street, Cairo, Egypt. (1932.)
127. Gibson, Miss C. J., B.A., 27, Banbury Road, Oxford. (1933.)
128. Gilbert, Dr E. M., Botanical Department, University of Wisconsin, Madison, Wis., U.S.A. (1922.)
129. Gilbert, M. E., Docteur en Pharmacie, 6, Rue de Laos, Paris (15$^{e}$), France. (1924.)
130. Gisborne, Mr J. H., Keble College, Oxford. (1932.)

131. Glasstone, Mrs V. F. C., B.A. (Oxon.), 15, Northumberland Road, Sheffield. (1930.)
132. Glynne, Miss Mary D., M.Sc., F.L.S., Rothamsted Experimental Station, Harpenden, Herts. (1932.)
133. Gorman, Mr M. J., A.R.C.Sc.I., Albert Agricultural College, Glasnevin, Dublin. (1925.)
134. Gough, Mr G. C., B.Sc., A.R.C.S., Ministry of Agriculture, Cornwall Buildings, 45, Newhall Street, Birmingham. (1923.)
135. Gould, Mr F. G., Woodrising, Trapps Hill, Loughton, Essex. (1918.)
136. Green, Col. C. Theodore, A.M.S., M.R.C.S., L.R.C.P., F.L.S., 31, Shrewsbury Road, Birkenhead. (1901.)
137. Green, Miss E., M.Sc., 15, Gower Street, London, W.C. 1. (1925.)
138. Green, Miss F. Mary, M.A., Ph.D., 63, Canford Road, Clapham Common, London, S.W. 11. (1931.)
139. Gregor, Mrs M. J. F., Ph.D., Royal Botanic Garden, Edinburgh. (1927.)
140. Gregory, Mr P. H., Ph.D., Seale Hayne Agricultural College, Newton Abbot, Devon. (1930.)
141. Grieve, Mr B. J., M.Sc., Botanical Department, Melbourne University, Carlton, Victoria, Australia. (1931.)
142. Grinling, Mr C. H., B.A., 71, Rectory Place, Woolwich, London, S.E. 18. (1913.)
143. Grove, Miss Jessica H., 14, The Tything, Worcester. (1927.)
144. Gwynne-Vaughan, Professor Dame Helen, G.B.E., D.Sc., LL.D., F.L.S., 93, Bedford Court Mansions, London, W.C. 1. (1906.)
145. Hall, Miss M. P., Ph.D. Plant Pathology Department, Imperial College of Science, South Kensington, London, S.W. 7. (1930.)
146. Hanna, Mr W. F., M.Sc., Dominion Rust Research Laboratory, Agricultural College, Winnipeg, Canada. (1925.)
147. Hansford, Mr C. G., M.A., F.L.S., Mycologist, Department of Agriculture, Kampala, Uganda. (1921.)
148. Harley, Mr J. L., 18, Oak Road, Newton Park, Leeds. (1932.)
149. Harris, Mr G. C. M., 148, Divinity Road, Oxford. (1934.)
150. Harris, Mr R. V., B.Sc., A.R.C.S. Horticultural Research Station, East Malling, Kent. (1924.)
151. Harrison, Mr T. H., D.Sc. Hawkesbury Agricultural College, Richmond, N.S. Wales, Australia. (1931.)
152. Harvard University, The Library, Cambridge, Mass., U.S.A. (1923.)

153. Hastings, Mr Somerville, M.S., F.R.C.S., 43, Devonshire Street, Portland Place, London, W. 1. (1913.)
154. Hawker, Miss L. E., Botanical Department, Imperial College of Science, London, S.W. 7. (1934.)
155. Heim, M. Roger, Sous-Directeur au Muséum d'Histoire Naturelle, 11, Rue de Médicis, Paris (6e), France. (1930).
156. Heimbeck, Mrs Louise, Brosoe, Levanger, Norway. (1923.)
157. Hemmi, Dr Takewo, Phytopathological Institute, Department of Agriculture, Kyoto Imperial University, Kyoto, Japan. (1923.)
158. Hereford, Mr E. H., 131, Queen Victoria Street, London, E.C. 4. (1933.)
159. Hildyard, Mr F. W., 1, Lichfield Road, Kew, Surrey. (1913.)
160. Hiura, Professor Makoto, Gifu Imperial College of Agriculture, Naka-Mura, Gifu, Japan. (1931.)
161. Holden, Professor H. S., D.Sc., F.L.S., Botanical Department, University College, Nottingham. (1923.)
162. Honolulu, Association of Hawaiian Pineapple Canners, P.O. Box 3166, Hawaii. (1929.)
163. Honolulu, The Library, Experimental Station, S.P.A., Box 411, Hawaii. (1920.)
164. Hopkins, Mr J. C. F., Agricultural Department, Salisbury, S. Rhodesia. (1930.)
165. Horne, Mr A. S., D.Sc., F.L.S., F.G.S., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1921.)
166. Howard, Mr H. J., F.R.M.S., F.L.S., "Lingfield", 6, College Road, Norwich. (1918.)
167. Hubbard, Miss M. D., B.Sc., Department of Botany, University College of Wales, Aberystwyth. (1933.)
168. Hughes, Mr G. C., 49, Balfour Road, Ilford. (1898.)
169. Hughes, Mr J. S., M.A., University Observatory, Oxford. (1927.)
170. Hull, The Librarian, Botanical Department, University College. (1929.)
171. Humphrey, Dr C. J., c/o Dr E. T. Bartholomew, Citrus Experiment Station, Riverside, California, U.S.A. (1921.)
172. Hurrell, Mr H. E., 60, Albany Road, Great Yarmouth. (1921.)
173. Hurst, Mr C. P., Landulph Rectory, Saltash, Cornwall. (1928.)
174. Iowa, The Library, State University of Iowa, Library Annex, Iowa City, U.S.A. (1923.)
175. Iowa State College, Library, Ames, Iowa, U.S.A. (1927.)
176. Issatchenko, Professor B. L., Directeur du Jardin Botanique, Leningrad, Russia. (1923.)

177. John Crerar Library, 86, East Randolph Street, Chicago, Illinois, U.S.A. (1929.)
178. John Innes Horticultural Institution, Mostyn Road, Merton Park, London, S.W. 19. (1924.)
179. Johnson, Mr J. W. Haigh, M.Sc., F.I.C., F.L.S., Walton, nr Wakefield. (1919.)
180. Johnstone, Mr R. B., 3, Oswald Gardens, Scotstounhill, Glasgow. (1908.)
181. Jones, Mr G. H., M.A., Plant Protection Section, Ministry of Agriculture, Cairo, Egypt. (1922.)
182. Jørstad, Mr Ivar, Statsmykolog, Botanisk Museum, Oslo, Norway. (1923.)
183. Keissler, Dr Karl, Direktor d. Botanischen Abteilung, Naturhistorisches Museum, Burgring 7, Wien 1/1, Austria. (1924.)
184. Kelly, Dr Howard A., 1418, Eutaw Place, Baltimore, Md., U.S.A. (1921.)
185. Kent, Mr G. C., Botany Department, Iowa State College, Ames, Iowa, U.S.A. (1932.)
186. Klika, Mr Bohumil, Hálkova 37, Prague, Vrsovice 553, Czechoslovakia. (1926.)
187. Knight, Mr H. H., M.A., The Lodge, All Saints' Villas, Cheltenham. (1914.)
188. Kuala Lumpur, F.M.S., The Director of Agriculture, Straits Settlements, and Federated Malay States. (1930.)
189. Lamb, Mr I. M., B.Sc., 38, Richmond Hill Court, Richmond, Surrey. (1934.)
190. Lampitt, Mr L. H., D.Sc., F.I.C., Thornlea, Mount Park, Harrow, Middlesex. (1925.)
191. Leach, Mr R., B.A., Agricultural Department, Mlanje, Nyasaland. (1929.)
192. Leicester, The Museum, City of Leicester. (1923.)
193. Lewis, Professor F. J., D.Sc., F.L.S., University of Alberta, Edmonton, Alberta, Canada. (1924.)
194. Line, Mr James, M.A., School of Agriculture, Cambridge. (1921.)
195. Linnean Society, The, Burlington House, Piccadilly, London, W. 1. (1919.)
196. Lloyd Library, The, 309, West Court Street, Cincinnati, Ohio, U.S.A. (1907.)
197. Loader, Miss F. M., B.Sc., Botanical Department, University College, Southampton. (1927.)
198. Lowndes, Mr A. G., M.A., F.L.S., Marlborough College, Marlborough, Wilts. (1922.)
199. Lütjeharms, Mr W. J., Assistent aan's Rijks Herbarium, Leiden, Holland. (1930.)

200. McDonald, Mr J., D.F.C., B.Sc., F.L.S., Mycologist, Department of Agriculture, Box 323, Nairobi, Kenya Colony, East Africa. (1923.)
201. Macdonald, Mr J., 25, Drumsheugh Gardens, Edinburgh. (1929.)
202. McFarland, Dr Frank T., Department of Botany, University of Kentucky, Lexington, Ky., U.S.A. (1924.)
203. McLennan, Dr Ethel I., Botanical Department, Melbourne University, Carlton, Victoria, Australia. (1926.)
204. Madras University Library, Senate House, Triplicane, Madras, South India. (1925.)
205. Maire, M. René, D.Sc., F.M.L.S., Professeur à la Faculté des Sciences de l'Université, Algiers, Algeria, N. Africa. (1907.)
206. Marsh, Mr R. W., M.A., Research Station, Long Ashton, Bristol. (1923.)
207. Martyn, Mr E. B., B.A., Department of Agriculture, Georgetown, British Guiana. (1927.)
208. Masefield, Mr G. B., Lee Cottage, Charlbury, Oxon. (1932.)
209. Mason, Mr E. W., M.A., M.Sc., F.L.S., Imperial Bureau of Mycology, 17, Kew Green, Kew, Surrey. (1921.)
210. Mason, Mrs E. W., Inglenook, 63, King's Road, Richmond, Surrey. (1922.)
211. Mason, Mr F. A., F.R.M.S., M.S.P.A., 29, Frankland Terrace, Leeds. (1912.)
212. Matthews, Professor J. R., M.A., F.L.S., Department of Botany, The University, Old Aberdeen. (1921.)
213. Mehta, Professor K. C., Ph.D., Department of Biology, Agra College, Agra, U.P., India. (1921.)
214. Melville, Mr R., B.Sc., Ph.D., Royal Botanic Gardens, Kew. (1933.)
215. Metcalfe, Mr C. R., B.A., Ph.D., Jodrell Laboratory, Royal Botanic Gardens, Kew, Surrey. (1926.)
216. Meulenhoff, Dr J. S., Ruychrocklaan 30, The Hague, Holland. (1921.)
217. Michigan Agricultural College Library, East Lansing, Michigan, U.S.A. (1924.)
218. Miller, Professor J. H., B.S., M.S., Ph.D., University of Georgia, Athens, Ga., U.S.A. (1930.)
219. Missouri, The Botanical Garden, St Louis, Mo., U.S.A. (1902.)
220. Mitra, Mr M., M.Sc., Ph.D., D.I.C., Assistant Mycologist, Imperial Institute of Agricultural Research, Pusa, Bihar and Orissa, India. (1928.)
221. Miyabe, Dr Kingo, Professor Emeritus of Botany, Hokkaido Imperial University, Sapporo, Japan. (1919.)

222. Montague, Mrs A., Penton, Crediton, N. Devon. (1898.)
223. Montana Experiment Station, Department of Botany and Bacteriology, Bozeman, Montana, U.S.A. (1930.)
224. Montreal, Canada, Faculté des Sciences, Institut Botanique, Université de Montréal. (1932.)
225. Moore, Mr W. C., M.A., Ministry of Agriculture, Pathological Laboratory, Milton Road, Harpenden, Herts. (1922.)
226. Morgan, Dr G., Ashley-Hatton, Dyke Road Avenue, Brighton. (1928.)
227. Morris, Mr L. E., 15, Tenison Avenue, Cambridge. (1924.)
228. Muller, Dr H. R. A., Institut voor Plantenziekten, Buitenzorg, Java. (1932.)
229. Murphy, Professor P. A., Sc.D., A.R.C.Sc.I., M.R.I.A., Department of Plant Pathology, Albert Agricultural College, Glasnevin, Dublin, N.W. 3. (1924.)
230. Murray, Mr G. H., F.E.S., Director of Agriculture, Rabaul, New Britain, Territory of New Guinea, *via* Australia. (1921.)
231. Muskett, Mr A. E., M.Sc., A.R.C.S., Queen's University, Belfast, Northern Ireland. (1923.)
232. Nannfeldt, Dr J. A., Sturegatan 11, Uppsala, Sweden. (1932.)
233. National Collection of Type Cultures, Curator, Lister Institute, Chelsea Gardens, London, S.W. 1. (1921.)
234. National Museum of Wales, Cardiff. (1924.)
235. Nattrass, Mr R. M., B.Sc. (Agric.), Ph.D., Department of Agriculture, Nicosia, Cyprus. (1925.)
236. Nebraska, The Library, University of, Lincoln, Nebr., U.S.A. (1924.)
237. Nederlandsche Mycologische Vereeniging, c/o Mr A. C. S. Schweers, Nassaulaan 17, Alkmaar, Holland. (1920.)
238. Nelson, Miss M. G., M.A., Botanical Department, The University, Oxford. (1932.)
239. New York Botanical Garden, Bronx Park, New York, U.S.A. (1904.)
240. Nicholson, Mr W. E., F.L.S., 50, St Anne's Crescent, Lewes. (1913.)
241. Noel, Miss E. F., F.L.S., 37, Burnham Court, Queen's Road, London, W. 2. (1913.)
242. Norman, Mr L. Stafford, Konjeni Estate, Luchenza P.O., Nyasaland. (1927.)
243. North Carolina, Library, University of, Chapel Hill, North Carolina, U.S.A. (1920.)
244. Nursery and Market Garden Industries' Development Society, Ltd., Experimental and Research Station, Cheshunt, Herts. (1922.)

245. Oberlin College, Oberlin, Ohio, U.S.A., Library, Department of Botany. (1933.)
246. O'Connor, Mr P., Ph.D., B.Sc., A.R.C.Sc.I., National Museum, Dublin. (1925.)
247. Ogilvie, Mr L., M.A., M.Sc., Research Station, Long Ashton, nr Bristol. (1922.)
248. Oke, Mr Alfred William, B.A., F.G.S., F.L.S., 32, Denmark Road, Hove, Sussex. (1908.)
249. Ontario Agricultural College, Library, Guelph, Ontario, Canada. (1920.)
250. Osborn, Professor T. G. B., D.Sc., F.L.S., Botanical Department, The University, Sydney, N.S.W., Australia. (1910.)
251. Ottawa, Ontario, Canada, The Library, Geological Survey. (1926.)
252. Overholts, Dr L. O., Botany Department, Pennsylvania State College, Pa., U.S.A. (1929.)
253. Page, Miss W. M., M.Sc., 19, Ledam Buildings, Bourne Estate, Holborn, London, E.C. 1. (1921.)
254. Park, Mr M., Department of Agriculture, Peradeniya, Ceylon. (1929.)
255. Parke Davis & Co., Medical Research Library, P.O. Box 488, Detroit, Michigan, U.S.A. (1920.)
256. Parker, Professor C. S., Department of Botany, Howard University, Washington, D.C., U.S.A. (1932.)
257. Pearson, Mr Arthur A., F.L.S., 59, Southwark Street, London, S.E. 1. (1911.)
258. Peklo, Dr Jaroslav, Professor of Applied Botany, Bohemian Technical University, Charles Square, Prague II, Czechoslovakia. (1924.)
259. Perthshire Society of Natural Science, c/o Mr James Winter (Hon. Treasurer), 35, George Street, Perth. (1919.)
260. Petch, Mr T., B.A., B.Sc., North Wootton, King's Lynn, Norfolk. (1911.)
261. Pethybridge, Mr G. H., Ph.D., B.Sc., F.L.S., Ministry of Agriculture, Pathological Laboratory, Milton Road, Harpenden, Herts. (1919.)
262. Peyronel, Dr Benjamino, R. Istituto Sup. Agrario e Forestale, Piazzale del Re, Firenze, Italy. (1932.)
263. Philadelphia, The Academy of Natural Sciences of Philadelphia, Nineteenth and The Parkway, Phil., U.S.A. (1925.)
264. Phillips, Dr H. H., 6, St John's Road, Penge, London, S.E. 10. (1923.)
265. Ping, Mr A. Wentworth, M.A., "St Olave's", Clifton, York. (1926.)

266. Plowright, Mr C. T. M., B.A., M.B., Darnick, Flore, Northampton. (1901.)
267. Potter, Rev. M. C., Sc.D., M.A., F.L.S., Corley Croft, New Milton, Hants. (1896.)
268. Preston, Mr N. C., B.Sc., Harper Adams Agricultural College, Newport, Salop. (1920.)
269. Pretoria, South Africa, The Chief, Division of Botany (91403), Department of Agriculture. (1922.)
270. Purdue University, Library, Agricultural Experiment Station, Lafayette, Ind., U.S.A. (1931.)
271. Pusa, Imperial Mycologist, Imperial Agricultural Research Institute, Pusa, Bihar, India. (1921.)
272. Ramsbottom, Mr J., O.B.E., M.A., F.L.S., British Museum (Nat. Hist.), Cromwell Road, South Kensington, London, S.W. 7. (1910.)
273. Ray, Miss Anne, Penarwyn, Gorran Haven, Gorran, Cornwall. (1929.)
274. Rayner, Dr M. Cheveley (Mrs Neilson Jones), Bedford College for Women, Regent's Park, London, N.W. 1. (1921.)
275. Rea, Miss M. W., M.Sc., Salem House, Sydenham, Belfast, Northern Ireland. (1920.)
276. Rees, Mr John, M.Sc., Adviser in Agricultural Botany, University College, Cardiff. (1929.)
277. Reichert, Dr Israel, Jewish Agency for Palestine, Agricultural Experiment Station, P.O.B. 15, Rehoboth, Palestine. (1924.)
278. Rhind, Mr Donald, B.Sc., Economic Botanist, Department of Agriculture, Agricultural College, Mandalay, Burma. (1922.)
279. Rhodes, Miss Mabel, Lister Institute, Chelsea Gardens, London, S.W. 1. (1921.)
280. Robson, Mr R., M.Sc., F.Z.S., East Hanningfield, Chelmsford, Essex. (1914.)
281. Roper, Miss Ida M., F.L.S., "The Curatage", 176, Chessell Street, Ashton Gate, Bristol 3. (1921.)
282. Rothamsted Experimental Station, Department of Mycology, Harpenden, Herts. (1923.)
283. Rutgers College and State University of New Jersey, Library, New Brunswick, New Jersey, U.S.A. (1922.)
284. St Paul, Minnesota, U.S.A., The Library, Department of Agriculture, University Farm. (1920.)
285. Salam, Mr M. M. Abdel-, Cotton Research Board, Giza, Egypt. (1930.)
286. Salisbury, Professor E. J., D.Sc., F.R.S., F.L.S., Botanical Department, University College, Gower Street, London, W.C. 1. (1921).

287. Salmon, Professor E. S., F.L.S., South-Eastern Agricultural College, Wye, Kent. (1922.)
288. Sampson, Miss K., M.Sc., University College, Aberystwyth, North Wales. (1920.)
289. Samuel, Mr Geoffrey, M.Sc., Department of Plant Pathology, Rothamsted Experimental Station, Harpenden, Herts. (1923.)
290. Scott, Mr W. W., 13, Bishop's Road, Highgate, London, N. 6. (1922.)
291. Searle, Mr G. Odell, B.Sc. (Agric.), Research Botanist, Linen Industry Research Association, Glenmore House, Lambeg, Lisburn, Northern Ireland. (1920.)
292. Seth, Mr N. L., B.Sc., Ph.D., D.I.C., Agricultural College, Mandalay, Burma. (1930.)
293. Sharples, Mr A., A.R.C.S., D.I.C., c/o Messrs Grindlay & Co., Parliament Street, London, S.W. 1. (1924.)
294. Shaw, Mr F. J. F., D.Sc., A.R.C.S., F.L.S., Imperial Agricultural Research Institute, Pusa, Bihar, India. (1920.)
295. Shear, Dr C. L., U.S. Department of Agriculture, Bureau of Plant Industry, Washington, D.C., U.S.A. (1930.)
296. Small, Mr W., M.B.E., M.A., Ph.D., B.Sc., Director, Department of Agriculture, Zomba, Nyasaland. (1915.)
297. Smith, Mr Alexander, M.A., Ph.D., Ministry of Agriculture, Pathological Laboratory, Milton Road, Harpenden, Herts. (1924.)
398. Smith, Miss K. E., The Quarry, Lutterworth Road, Nuneaton. (1913.)
399. Smith, Professor Noel J. G., Ph.D., B.Sc., Botany Department, Rhodes University College, Grahamstown, S. Africa. (1924.)
300. Smith, Mr Rupert, 38, Greenhill Gardens, Edinburgh. (1927.)
301. South London Botanical Institute, 323, Norwood Road, Tulse Hill, London, S.E. 24. (1921.)
302. Stakman, Professor E. C., University of Minnesota, Department of Agriculture, University Farm, St Paul, Minn., U.S.A. (1922.)
303. Statham, Miss E. M., 2, Westbrook Road, Blackheath, London, S.E. 3. (1926.)
304. Stationery Office, H.M., Superintendent of Publications, Book Dept., Westminster, S.W. 1. (4 subscriptions.) (1920.)
305. Stephens, Miss E. L., B.A., Department of Botany, University of Cape Town, Cape Town, South Africa. (1928.)
306. Stephens, Miss F. L., M.Sc., Department of Botany, British Museum (Natural History), Cromwell Road, South Kensington, London, S.W. 7. (1930.)

307. Steyaert, M. R. L., Station de Sélection Cotonnière de Bambesa, District des Uélés, Belgian Congo. (1931.)
308. Stirrup, Mr H. H., M.Sc., Midland Agricultural College, Sutton Bonington, Loughborough. (1922.)
309. Storey, Mr H. H., M.A., Ph.D., East African Agricultural Research Institute, Amani, Tanganyika Territory, East Africa. (1922.)
310. Sutherland, Mr G. K., M.A., D.Sc., F.L.S., "Bremhill", 21, Combe Park, Bath, Somerset. (1914.)
311. Swansea Field Naturalists' Society, c/o Mr E. R. Brown, 71, Rhyddings Park Road, Swansea, South Wales. (1924.)
312. Swanton, Mr E. W., A.L.S., Educational Museum, Haslemere, Surrey. (1899.)
313. Swedish Academy of Sciences, Royal, Stockholm, Sweden. (1919.)
314. Sydney, Australia, The Librarian, University of. (1922.)
315. Sydow, Herr H., Luitpoldstrasse 33, Berlin, W. 30, Germany. (1931.)
316. Tabor, Mr R. J., B.Sc., F.L.S., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1914.)
317. Taylor, Mr J. C., B.Sc., B.Agr., Department of Agricultural Botany, Queen's College, Belfast, N. Ireland. (1933.)
318. Telfer, Mr R. Allsop, 7, Christchurch Road, Worcester. (1931.)
319. Tennessee, University of, Agricultural Experiment Station, Library, Knoxville, Tennessee, U.S.A. (1926.)
320. Tervet, Mr I. W., B.Sc., c/o G. M. Tervet, Esq., 11, Whitehaugh Drive, Paisley. (1933.)
321. Tetley, Miss U., Quarry Garth, Windermere, Westmoreland. (1929.)
322. Tomkins, Mr R. G., M.A., Ph.D., Trinity College, Cambridge. (1925.)
323. Tunstall, Mr A. C., Tocklai Experimental Station, Cinnamara P.O., Assam, British India. (1933.)
324. United States Department of Agriculture, c/o Wheldon and Wesley, 2–4 Arthur Street, New Oxford Street, London, W.C. 2. (1907.)
325. Vaheeduddin Syed, Department of Plant Pathology, University Farm, St Paul, Minnesota, U.S.A. (1934.)
326. Vanterpool, Mr T. C., M.Sc., Botanical Department, University of Saskatchewan, Saskatoon, Canada. (1929.)
327. Vasudeva, Mr R. S., Cotton Pathologist, Agricultural College, Lyallpur, Punjab, India. (1929.)

328. Wadham, Professor S. M., M.A., Department of Agriculture, The University, Melbourne, Victoria, Australia. (1922.)
329. Wakefield, Miss E. M., M.A., F.L.S., Herbarium, Royal Botanic Gardens, Kew. (1911.)
330. Waldie, Mr J. S. L., B.Sc., C.D.A., Department of Agricultural Botany, The University, Reading. (1925.)
331. Wales, University College of, Librarian, Botanical Department, Aberystwyth, North Wales. (1927.)
332. Wallace, Mr E. R., Agricultural Institute, Kirton, nr Boston, Lincs. (1934.)
333. Wallace, Mr G. B., B.Sc. (Agric.), Ph.D., Department of Agriculture, Morogoro, Tanganyika Territory, East Africa. (1928.)
334. Wallace, Mrs G. B., B.Sc., Morogoro, Tanganyika Territory, East Africa. (1924.)
335. Wallis, Mr A., Westacre, Station Road, Kettering. (1921.)
336. Ware, Mr W. M., D.Sc., South-Eastern Agricultural College, Wye, Kent. (1924.)
337. Washington, Library, State College of, Pullman, Washington, U.S.A. (1924.)
338. Waterston, Mr J. M., B.Sc., The Botany School, Cambridge. (1934.)
339. Watson, Mr W., D.Sc., A.L.S., Cedene, Cheddon Road, Taunton. (1933.)
340. Welsmann, Dr Ludwig, Pelkum, bei Hemm, Westphalia, Germany. (1932.)
341. Westerdijk, Professor Johanna, Javalaan 4, Baarn, Holland. (1923.)
342. Western, Mr J. H., B.Sc., Department of Agricultural Botany, University College of Wales, Aberystwyth. (1934.)
343. Weston, Mr W. A. R. Dillon, M.A., School of Agriculture, Cambridge. (1923.)
344. Whetzel, Professor H. H., M.A., New York State College of Agriculture, Cornell University, Ithaca, N.Y., U.S.A. (1914.)
345. Whitaker, Mr F. Owen, 51, Grosvenor Avenue, Carshalton, Surrey. (1921.)
346. Whitehead, Mr T., D.Sc., A.R.C.S., University College of North Wales, Bangor. (1920.)
347. Wilkins, Mr W. H., M.A., Department of Botany, The University, Oxford. (1928.)
348. Williams, Mr P. H., 4, Belmont Villas, Windmill Lane, Cheshunt, Herts. (1930.)
349. Wilson, Miss A. P., M.B.E., A.R.C.S., 116, Fellows Road, London, N.W. 3. (1929.)

350. Wilson, Mr Alastair R., B.Sc., The Botany School, Cambridge. (1933.)
351. Wilson, Mr Malcolm, D.Sc., A.R.C.S., F.L.S., Royal Botanic Garden, Edinburgh. (1921.)
352. Wiltshire, Mr S. P., M.A., Imperial Mycological Institute, Ferry Lane, Kew, Surrey. (1920.)
353. Wisconsin, The Library, University of, Madison, Wis., U.S.A. (1923.)
354. Wolf, Mr B. L., N.D.A., Cornwall Buildings, 45, Newhall Street, Birmingham. (1923.)
355. Woodcock, Mr A. J. A., M.Sc., F.E.S., Rhianva, 65, Rock Avenue, Gillingham, Kent. (1926.)
356. Woodward, Mr R. C., Ph.D., Imperial Chemical Industries, Ltd., Millbank, London, S.W. 1. (1924.)
357. Woolhope, The Naturalists' Field Club, Hereford. (1896.)
358. Worcestershire Naturalists' Field Club, c/o Mr W. J. Else, Victoria Institute, Worcester. (1921.)
359. Wormald, Mr H., D.Sc., A.R.C.S., Research Station, East Malling, Kent. (1921.)
360. Wright, Mr E. Barton, M.Sc., Scottish Society for Research in Plant Breeding, Craig's House, Corstorphine, Midlothian. (1926.)
361. Yale University, Library, New Haven, Connecticut, U.S.A. (1930.)
362. Yeoman, Mr J. B., M.D., Norton, Wirral, Cheshire.
363. Young, Miss Elaine M., Ph.D., M.Sc., University of the Witwatersrand, Johannesburg, South Africa. (1927.)
364. Zundel, Dr G. L. I., Botany Building, Pennsylvania State College, State College, Pa., U.S.A. (1929.)
365. Zürich, Switzerland, Botanical Garden and Museum, c/o Dr A. U. Däniker. (1921.)
366. Zürich, Institut für Spezielle Botanik der Eidg. Techn. Hochschule. (1928.)

# RULES

*Society's Name and Objects*

1. The Society shall be called "The British Mycological Society", and its object shall be the study of Mycology in all its branches.

*Members of Society*

2. The Society shall consist of Honorary Members, Foundation Members and Ordinary Members; the number of Honorary Members shall be limited to 20, and that of Foundation Members to 100, but the number of Ordinary Members shall be unlimited.

*Honorary Members*

3. Honorary Members shall be persons of pre-eminence in Mycology, or who have rendered special service to the Society.

*Foundation Members*

4. Foundation Members shall be those Members or Societies who joined the Society previous to the limit of 100 Members having been attained.*

*Officers*

5. The Officers of the Society shall consist of a President, one or more Vice-Presidents, Treasurer, Secretaries, and Editor or Editors. They shall be elected annually, at the Annual General Meeting of the Society.

*Government of Society*

6. The government of the Society shall be vested in a Council, which shall consist of the President and other Officers for the time being, together with two or more other Members who shall be elected annually at the General Meeting, and one-half of whom shall retire each year and not be eligible for immediate re-election. The Members to retire shall be those who have been longest in office or, in case of equality, shall be determined by ballot. Ex-Presidents are *ex-officio* Members of the Council.

Every Meeting of the Council shall be duly summoned by the Hon. Secretary by at least seven days' notice in writing to each Member of the Council.

*Period of Office*

7. The Officers and Council shall hold office as from the 1st of January following their election.

* The limit of 100 Foundation Members was reached 22nd October, 1903.

*Plant Pathology Committee*

8. The special interests of Plant Pathology shall be delegated to an executive committee, to be called the Plant Pathology Committee of the British Mycological Society. This Committee shall consist of the President and Secretaries *ex-officio* and twelve other members of the Society. The latter shall be elected annually at the Annual General Meeting of the Society, and one-quarter shall retire in rotation each year and shall not be eligible for immediate re-election. The members to retire shall be those who have been longest in office, or, in case of equality, shall be determined by ballot.

The Officers shall consist of a Chairman and a Secretary, to be elected by the Committee each year.

At least two meetings shall be held every year, six members to form a quorum.

The Committee shall have power to appoint for any special purpose a sub-committee consisting either wholly or partly of members of the Committee.

*Election of Members*

9. Honorary Members shall only be elected at a Meeting of the Society by a majority of the Members then present.

All Ordinary Members shall be proposed and seconded respectively by existing Members, who shall sign a certificate (see Appendix) of recommendation, one at least of the proposers so certifying from personal knowledge. Every candidate for election shall sign an undertaking to abide by the Rules if elected (see Appendix). They shall be elected by a majority of the Members present at any meeting of the Society or by the President and Officers of the Society.

*Subscription*

10. All Ordinary Members and Societies shall pay an annual subscription of one pound, and Foundation Members five shillings, due on the 1st of January in each year. Honorary Members shall be exempt from any annual subscription.

Any Member wishing to retire from the Society shall give notice to the Hon. Secretary or Treasurer in writing before the 1st of December of the previous year.

*Meetings*

11. The Society shall hold one or more meetings annually, at a place and time determined by the Members at the preceding Annual General Meeting, or by the Council. The Annual General Meeting, for the election of officers and the transaction of other business, shall coincide with the Autumn Foray.

*Accounts*

12. At the Annual General Meeting of the Society in each year the Hon. Treasurer shall present duly audited accounts.

*Alteration of Rules*

13. The Rules shall not be altered except by a two-thirds majority of the Members present at an Annual General Meeting. A printed copy shall be sent to every Member of the Society on election, and in the event of alterations to all Members.

## APPENDIX

*Form of proposal for Ordinary Membership of the British Mycological Society*

.....

*of*.....

.....

being desirous of becoming an Ordinary Member of the British Mycological Society, we, the undersigned Members of the Society, certify that we consider h to be a desirable Member of the Society, and beg to recommend h for election.

Dated this day of 19

.....(From personal knowledge.)

---

*Certificate to be signed by the Candidate*

I hereby certify that I desire to become an Ordinary Member of the British Mycological Society and that I will abide by the Rules if elected.

.....

# INDEX

New names are indicated by an asterisk.


Abies alba, 195, 196, 197
  sibirica, 196
Acetobacter Beijer, 316
Achlya Nees, 227
  americana Humph., 228, 229
  apiculata de Bary, 227, 238
  apiculata de Bary, var. prolifera Coker & Couch, 232, 238
  asterophora von Minden, 230
  caroliniana Coker, 229, 238
  colorata Pringsh., 227, 238
  de Baryana Humph., 225, 227, 228, 229, 238
  de Baryana Humph., f. americana Peters., 228
  decorata Peters., 230
  gracilipes de Bary, 227
  intermedia Bail, 225
  Klebsiana Pieters, 229, 238
  megasperma Humph., 231, 238
  oblongata de Bary, 230, 238
  *oblongata de Bary, var. gigantica E. J. Forbes, 231, 238
  Orion Coker & Couch, 230, 238
  polyandra de Bary, 227, 228, 238
  polyandra Hildeb., 227
  prolifera Pringsh., 223
  racemosa Hildeb., var. stelligera Cornu, 227
  radiosa Maurizio, 230, 238
  recurva Cornu, 231, 238
Acia denticulata (Pers.) Bourd. & Galz., 282
  uda (Fr.) Bourd. & Galz., 282
Aecidium Pers., 136, 137
  Berberidis Gmel., 137
Agarics, an evolutionary study in: *Collybia apalosarca* and the veils, by E. J. H. Corner, 39
Agaricus L., 38
Agropyron Smithii, 345
Aleuria Fuck., 280
  vesiculosa (Bull.) Boud., 283
Allium schoenoprasum, 115
Alternaria Nees, 147, 190
  humicola Oud., 147
  tenuis Nees, 147
Amanita (Pers.) Fr., 39, 71, 82, 83
  gemmata Fr., 39
  junquillea Quél., 39
Amanitopsis Roze, 82, 83
  adnata (W. G. Sm.) Sacc., 39
Amphichaeta Davisiae McAlp., 139
  Kennedyae McAlp., 139
*Amphichaeta Punicae Chaudhuri & Singh, n.sp., 139, 144
Androsaceus (Pers.) Pat., 79
  graminum (Lib.) Pat., 280
Annellaria separata (L.) Karst., 282
Anthostomella tomicum (Lév.) Sacc., 284
Aonidia Lauri, 191
Aphrophora spumaria, 179
Aplanobacter Agropyri O'Gara, 345
  Rathayi E. F. Sm., 345
Apodya lactea Cornu, 234
Aposphaeriopsis Died., 261
  fusco-atra Died., 262, 277
Araucaria, 40, 47
Armillaria Fr., 39–86
  mellea (Vahl) Fr., 39, 78, 79
  mucida (Schrad.) Fr., 39–87
Aschersonia Mont., 181
  caespiticia Syd., 181
Ascobolus furfuraceus Pers., 283
Ascochyta Lib., 146
Ascophanus carneus (Pers.) Boud., 283
  ochraceus (Cr.) Boud., 283
Ashworth, D., "An experimental and cytological study of the life history of *Endophyllum Sempervivi*", 240
Aspergillus Fr., 146, 315
  herbariorum (Wigg.) Fisch., 277
  niger van Tieg., 22, 23
Aspidiotus, 193
Association between the Gasteromycete *Polysaccum* and *Eucalyptus* roots, by N. J. G. Smith and F. B. Pope, 95

Bacillus, 316
Bacterium, 316
  Tritici, 345
  Savastanoi E. F. Sm., 346
  Savastanoi var. Fraxini, 346
Barnes, B., "On variation in *Thamnidium elegans* Link, induced by the action of high temperatures", 291
Batarrea Pers., 159
Beauveria Bassiana (Berk.) Vuill., 189
  densa (Link) Vuill., 38
  Peteloti Vincens, 187
Belonidium vexatum de Not., 283
Belonium excelsius (Karst.) Boud., 283
  filisporum (Cke.) Sacc., 283
Berberis (barberry), 128–38
Blackwell, E. M., "The germination of oospores of *Phytophthora Cactorum*", 157
Blastocladia Reinsch, 221, 222, 237
  Pringsheimii Reinsch, 227, 238

Blastocladiaceae, 237
Blastocladiales, 221, 237
*Blastotrichum Aranearum Petch, n.sp., 185, 186
confervoides Corda, 185
Bolbitius vitellinus (Pers.) Fr., 282
Boletus (Dill.) Pat., 39, 96, 158
appendiculatus (Schaeff.) Fr., 96
erythropus (Pers.) Quél., 96
luridus (Schaeff.) Fr., 96
miniatosporus Secr., 96
perniciosus Roques, 96
purpureus Fr., 96
Queletii Schulz, 96
rhodoxanthus (Kalchbr.) Kallenb., 96
satanas Lenz, 96
Bose, S. R., "A luminous agaric (*Pleurotus* sp.) from South Burma", 97
Botrytis Fr., 30
Botrytis Allii Munn., 27, 29
cinerea Pers., 13–32, 146, 270, 291–311
Tilletii Desm., 38
Brassica (turnip), 114, 122, 125
Brevilegnia Coker, 223, 233
diclina Harvey, 233, 238
British Guiana, exhibit of fungi from, by E. M. Wakefield, 159
British Pyrenomycetes, studies on. I. The life histories of three species of *Cephalotheca* Fuck., by C. G. C. Chesters, 261
British water moulds (Saprolegniales and Blastocladiales), observations in some, by E. J. Forbes, 221
Brown, W., Presidential Address, "Mechanism of disease resistance in plants", 11
Buller, A. H. R., "*Omphalia flavida*, a luminous and gemmiferous leaf-spot fungus", 94
Bungea Pers., 159
Byssostilbe Petch, 164

Calluna vulgaris, 338
Calocera viscosa (Pers.) Fr., 35
Calonectria xantholeuca (Kunze) Sacc., 284
Calycella citrina (Hedw.) Quél., 283
claroflava (Grev.) Boud., 283
uliginosa (Fr.) Boud., 283
Calyptralegnia Coker & Couch, 232
achlyoides Coker & Couch, 232, 238
Candida sitophila (Mont.) Jacz., 217
Cantharellus Adans., 61, 79
Carduus arvensis, 179
Carex, 287
Carpenteles asperum (Langeron) Shear, 277
Carpinus (hornbeam), 138
Carter, F. M., "A brief account of fungi present in the air over orchards, with especial reference to *Pleospora* and *Polyopeus*", 145
Catinella olivacea (Batsch) Boud., 283
Cauloglossum transversarium (Bosc) Fr., 166
Cayley, D. M., "Field observations on, and cultural experiments with, wild and cultivated forms of edible mushroom", 344
Cephalotheca Fuck., 261–78
*purpurea (Shear) Chesters, comb.nov., 262–78
reniformis Sacc. & Therry, 262–78
sulfurea Fuck., 262–78
trabea Fuck., 263
Cephalothecium Corda, 147
Ceratiomyxa fruticulosa Macbr., 35
Ceratium Alb. & Schw., 35, 36
Ceratonema Pers., 38
Chaetocladium Fres., 312
Chaetomium Kze., 146
Chalaropsis Peyr., 158, 159
thielavoides Peyr., 158, 159
Chaudhuri, H. and Singh, J., "A disease of pomegranate (*Punica granatum* Linn.) due to *Amphichaeta Punicae* n.sp.", 139
Cheilymenia dalmeniensis (Cke.) Boud., 283
Cheiranthus (Wallflower), 114, 115
Chermes, 191
Chesters, C. G. C., "Studies on British Pyrenomycetes. I. The life histories of three species of *Cephalotheca* Fuck.", 261
Ciboria Fuck., 212
amentacea (Balb.) Fuck., 283
Cicada, 174, 189
Ciliaria Quél., 280
asperior (Nyl.) Boud., 283
hirta (Schum.) Rehm, 283
scutellata (L.) Quél., 283
Cladium, 282, 283, 285
Mariscus, 280, 285
Cladosporium Link, 146, 190, 191, 192, 193
aphidicola Massalongo, 192
Aphidis Thuem., 190, 191
Aphidis Thuem., var. Muscae Br. & Har., 190, 192
herbarum Link, 190, 191, 192, 193
herbarum Pers., 146
herbarum Pers. var. aphidicola Massalongo, 191
herbarum Pers. var. aphidis Fuck., 190, 191, 193
Lauri Raybaud, 191, 192
parasiticum Sorok., 191, 192
penicillioides Preuss, 190, 192
Claudopus byssisedus (Pers.) Fr., 282
variabilis (Pers.) W. G. Sm., 282
Clavaria Holmsk., 38, 61
Claviceps Tul., 281
microcephala (Wallr.) Tul., 281, 284
Clitocybe Fr., 39, 74, 78, 79
atrialba (Murr.) Kauff., 76
cerussata Fr., 81
dealbata (Sow.) Fr., 344
tabescens (Scop.) Bres., 77

Clitopilus noveboracensis Peck, 81
Cochlearia, 114
Coleosporium Rhinanthacearum Lév., 283
  Senecionis Fr., 283
  Sonchi Lév., 283
  Tussilaginis Tul., 283
Coleroa Chaetomium (Kunze) Rabenh., 284
Colletotrichum Corda, 331, 333
  Camelliae Mass., 331
  circinans Vogl., 27
Collybia Fr., 74, 78, 79
  alphitophylla B. & Curt., 77
  altissima Massee, 67
  apalosarca B. & Br., 39–87
  *apalosarca B. & Br., f. radicans Corner, f.nov., 41, 71, 85
  *apalosarca B. & Br., var. perstipitata Corner, var.nov., 41–86
  atrialba Murrill, 77
  cheimonophylla Berk. & Curt., 76, 77
  fusipes (Bull.) Berk., 76
  Henriettae W. G. Sm., 76
  longipes (Bull.) Berk., 76, 77, 78, 85
  longipes (Bull.) Berk., var. badia Lucand, 76
  maculata (A. & S.) Fr., 76
  platyphylla (Pers.) Fr., 74, 76
  radicata (Relh.) Berk., 39–86
  radicata (Relh.) Berk., var. gracilis Lange, 72, 76
Conferva lactea Roth, 234
Coniothyrium (Corda) Sacc., 146
Coprinus (Pers.) Fr., 78
  cordisporus Gibbs, 282
  ephemeroides (Bull.) Fr., 81
  ephemerus (Bull.) Fr., 81, 282
  Friesii Quél., 280, 282
  lagopus Fr., 81
  niveus (Pers.) Fr., 282
  plicatilis (Curt.) Fr., 282
  stercorarius Fr., 81
Coprobia granulata (Bull.) Boud., 283
Cordyceps Fr., 161–74
  ainictos Möller, 163, 164
  amazonica P. Henn., 173
  atrobrunnea Penz. & Sacc., 170
  Barnesii Thw., 170, 176
  corallomyces Möller, 164
  ctenocephala Syd., 173, 174
  Cusu Pat., 168
  dipterigena B. & Br., 163, 164, 186
  Engleriana P. Henn., 161, 162
  flavo-viridis Möller, 162
  Fleischeri Penz. & Sacc., 170
  goniophora Speg., 172
  gracilis (Grev.) Dur. & Mont., 176
  herculea (Schw.) Sacc., 166
  Humberti Robin, 170, 172
  Hunti Giard, 165
  insignis Cke. & Rav., 166, 168, 169, 170
  isarioides Curtis, 173
  Joaquiensis P. Henn., 174
  locustiphila P. Henn., 173
Cordyceps Lunti Giard, 164
  martialis Speg., 165
  Melolonthae (Tul.) Sacc., 165–76
  militaris Link, 177
  myosuroides P. Henn., 171, 172
  obtusa Penz. & Sacc., 170
  Pittieri Bomm. & Rouss., 165
  Puiggarii Speg., 172, 173
  sobolifera (Hill) Sacc., 167–77
  sphecocephala (Kl.) Cke., 171, 172
  sphingum (Schw.) B. & C., 173, 174
  Stenocori Quél., 177
  stiphrodes Syd., 173
  submilitaris P. Henn., 165
  tuberculata (Lebert) Maire, 173
  Uleana P. Henn., 173, 174
  unilateralis (Tul.) Sacc., 163, 183
  Voeltzkowii P. Henn., 175, 176, 177
  Volkiana Möller, 167
Coriolus obducens Pers., 197
Corner, E. J. H., "An evolutionary study in agarics: *Collybia apalosarsa* and the veils", 39
  "The fungi of Wicken Fen, Cambridgeshire", 280
Cornus, 283
  Mas, 199, 213
  sanguinea, 135, 190
Corticium Pers., 280
  confluens Fr., 282
  coronatum (Schroet.) v. Hoehn. & Litsch., 4
  flavescens (Bon.) Mass., 282
  Sambuci (Pers.) Fr., 282
  Solani Prill. & Del., 89
Cortinarius Fr., 78, 82
  flexipes Fr., 282
  triumphans Fr., 4
Corydalis glauca, 115
Corylus (hazel), 138
Coryne sarcoides (Jacq.) Tul., 283
Crataegus, 102
Craterellus Fr., 79
Crepinula O. Kuntze, 261
Cribraria macrocarpa Schroder, 10
  rufa (Roth.) Rost., 10
Cruciferae, 114
Cyathicula coronata (Bull.) de Not., 283
Cyphella capula (Holmsk.) Fr., 282
  capula (Holmsk.) Fr., var. flavescens Pat., 282
  lactea Bres., 282
Cystopus candidus (Pers.) Lév., 284

Dactylis glomerata, 345
Daldinia concentrica (Bolt.) Ces. & de Not., 215
Dasyobolus immersus (Pers.) Sacc., 283
Dasyscypha Fr., 280
  acutipila (Karst.) Sacc., 283
  bicolor (Bull.) Fuck., 283
  calyculaeformis (Schum.) Rehm, 283
  controversa (Cke.) Rehm, 283

Dasyscypha crystallina (Fuck.) Sacc., 283
crucifera (Phill.) Sacc., 283
patens (Fr.) Sacc., 283
rosea Rehm, 283
spiraeaecola (Karst.) Sacc., 283
virginea (Batsch) Fuck., 283
Datura, 191
Dennis, R. W. G., "Notes on the occurrence of *Pyrenophora Avenae* Ito, in Scotland", 288
Dermatea Frangulae (Fr.) Tul., 284
Dictyuchus Leitgeb, 232
monosporus Leitgeb, 232, 238
Didymosphaeria commanipula (B. & Br.) Niessl, 284
Diplanes saprolegnioides Leitgeb, 225
Diplodia Fr., 146
Disease of pomegranate (*Punica granatum* Linn.) due to *Amphichaeta Punicae* n.sp., by H. Chaudhuri and J. Singh, 139
Disease resistance in plants, mechanism of. Presidential address by W. Brown, 11
Doassansia Sagittariae (West.) Fisch., 283
Dowson, W. J., "*Phytophthora megasperma* Dreschler in Tasmania", 89
"The occurrence of *Aplanobacter Rathayi* in Britain", 345
Draba, 115

Eccilia griseo-rubella (Lasch) Fr., 282
Eidamia Lindau, 146
Ellis, E. H., "Preliminary observations on Mycorrhiza", 157
Empusa Cohn, 180, 192, 193
empta Dustan, 181
Fresenii Nowak., 193
Muscae Cohn, 180, 181, 192
Encoelia furfuracea (Roth.) Karst., 284
Endophyllum Lév., 240, 241, 242, 245
Centranthi-rubi Poir., 241
Euphorbiae-sylvaticae (DC.) Wint., 241
*Endophyllum Sempervivi*, an experimental and cytological study of the life history of, by D. Ashworth, 240
Endophyllum Sempervivi de Bary, 240–56
tuberosae [Valerianae-tuberosae Maire], 241
Entomogenous fungi, notes on, by T. Petch, 161
Entomophthora Fres., 192
Aphrophorae Rostrup, 179, 180
Scatophagae Giard, 181
sphaerosperma Fres., 179, 180
Syrphi Giard, 181
Entomophthoraceae, 180
Epichloe typhina (Pers.) Tul., 338
Epicoccum granulatum Periz., 147
Epithele Typhae (Pers.) Pat., 282
Erinella hapala (B. & Br.) Sacc., 284
Nylanderi Rehm, 284
Erysimum, 115
Erysiphe Hedw. f., 136
Erysiphe Berberis Hedw., 136
Cichoracearum DC., 284
communis (Wallr.) Fr., 284
graminis DC., 284
Martii Lév., 284
Eucalyptus, 95
Eucharis, 18
Eugenia, 178
Euphorbia, 185
amygdaloides, 241
Eurotium herbariorum (Wigg.) Link, 154, 291, 299, 311
Exidia nucleata (Schw.) Rea, 283
Experiments on finger-and-toe disease (*Plasmodiophora Brassicae*), by G. Potts, 114

Fairmania Sacc., 261
singularis Sacc., 262, 277, 278
Field observations on, and cultural experiments with, wild and cultivated forms of edible mushroom, by D. M. Cayley, 344
Fire blight of apples, 346
Fisher, E., "Observations on *Fomes pomaceus* (Pers.) Big. & Guill., infecting plum trees", 102
Fomes applanatus (Pers.) Fr., 103, 104
igniarius (Linn.) Fr., 102, 103, 110
*Fomes pomaceus* (Pers.) Big. & Guill., infecting plum trees, by E. Fisher, 102
Fomes pomaceus (Pers.) Big. & Guill., 102, 103, 104, 105, 106, 109, 110, 111, 112
Forays:
Lyndhurst, 1
Newcastle, 4
Forbes, E. J., "Observations on some British water moulds (Saprolegniales and Blastocladiales)", 221
*Fragmenta Bibliographica*, by J. Ramsbottom, 159
Fragosphaeria Shear, 261, 263, 278
purpurea Shear, 267
Fraxinus (ash), 346
Fumaria officinalis, 115
Fungi of Wicken Fen, Cambridgeshire, by E. J. H. Corner, 280
Fungi present in the air over orchards, a brief account of, with especial reference to *Pleospora* and *Polyopeus*, by F. M. Carter, 145
Fusarium Link, 23, 147
culmorum (W. G. Sm.) Sacc., 147
fructigenum Fr., 147

Galactinia Cke., 280
badia (Pers.) Boud., 284
succosa (Berk.) Sacc., 284
Galera hypnorum (Schrank) Fr., 282
tenera (Schaeff.) Fr., 282
Gastromgius, 137
Gibberidea Fuck., 92
Giberella Saubinetii (Mont.) Sacc., 30

Glomerella Schrenk & Spauld., 331, 333
*Glomerella*, a new species of, on *Camellia Theae*, by A. C. Tunstall, 331
Glomerella cingulata (Stonem.) Spauld. & von Schr., 331–6
*major A. C. Tunstall, n.sp., 331–6
Grandinia mutabilis (Pers.) Bourd. & Galz., 282
Gupta, D. D., "Note on the isolation of single-spore cultures", 154
Gymnosporangium Hedw. f., 35

Hamond, J. B., "A graft disease of walnuts, caused by a species of *Chalaropsis*", 158
Harrison, T. H., and El-Helaly, A. F., "On *Lambertella Corni-maris* von Höhnel, a brown-spored parasitic Discomycete", 199
Hebeloma Fr., 39
subsaponaceum Karst., 4
Helminthosporium Link, 288, 290, 339
Avenae Eidam, 288, 290
Helotium Fr., 280
amenti (Batsch) Fuck., 284
cyathoideum (Bull.) Karst., 284
eburneum (Desm.) Gill., 284
epiphyllum (Pers.) Fr., 284
gramineum Phill., 284
herbarum (Pers.) Fr., 284
phyllogenum Rehm, 284
phyllophilum (Desm.) Karst., 284
salicellum (Hazl.) Fr., 284
scutula (Pers.) Karst., 284
tetra-ascosporum Rea, 284
virgultorum (Wallr.) Karst., 284
Hesperis, 115
Heteroecism, L. G. Windt and, by J. Ramsbottom, 128
Heterosphaeria patella (Tode) Grev., 284
Hirsutella Pat., 164, 183, 187
Eleutheratorum (Nees) Petch, 177
entomophila Pat., 182, 183, 187
floccosa Speare, 187
*formicarum Petch, n.sp., 183
*radiata Petch, n.sp., 184
Saussurei (Cke.) Speare, 171, 172, 187
versicolor Petch, 182
Hyalinia inflatula (Karst.) Boud., 284
Hyaloscypha hyalina (Pers.) Boud., 284
Hygrophorus Fr., 74, 78, 79
Hygrophorus conicus (Scop.) Fr., 280, 282
Hymenochaete Lév., 194
Hymenogaster tener Berk., 281, 282
Hymenostilbe Petch, 161, 172
Hypholoma Fr., 78, 83
appendiculatum (Bull.) Fr., 82, 282
Hypochnus fuscus (Pers.) Fr., 282
granulosus (Peck) Burt., 282
roseo-griseus Wakef. & Pears., 282
Hypocrea Fr., 167
Hypocrella Amomi Rac., 181

Iberis (candy tuft), 114, 122, 125
Inocybe Fr., 78, 85, 280
geophylla (Sow.) Fr., 282
geophylla (Sow.) Fr., var. fulva Pat., 282
rimosa (Bull.) Fr., sensu Rea, 282
Irpex obliquus (Schrad.) Fr., 282
"*Isaria*", by T. Petch, 34
Isaria, 34, 35, 36, 177
Isaria Fries, 37, 38
Isaria Hill, 34, 36, 37
Isaria Lindau, 37
Isaria Link, 36
Isaria Nees, 36
Isaria Pers., 36, 37, 38
Isaria Sacc., 37
Isaria agaricina Pers., 35, 37
brachiata (Batsch) Schum., 35
bulbosa Nees, 36
Cicadae Miq., 174
crassa Pers., 35, 36, 38
crinita Lloyd, 172
farinosa (Dicks.) Fr., 35, 36, 38, 177
flavo-viridis Möller, 162
glauca Ditm., 36
intricata Fr., 36, 37
mucida Pers., 35, 37
ramosa bifida Hill, 35
ramosa varie divisa Hill, 34
ramosissima Zoll. & Mor., 183
Saussurei Cke., 171, 172
simplex Hill, 34
sphecophila Ditm., 38
terrestris Fr., 36
truncata Pers., 36, 38
velutipes Link, 35, 36
Isatis, 114

Juglans (walnut), 158
Juncus, 179, 180

Laccaria laccata (Scop.) B. & Br., 79
Lachnea hemisphaerica (Wigg.) Gill., 284
Lachnella albotestacea (Desm.) Quél., 284
canescens (Phill.) Cke., 284
leucophaea (Pers.) Boud., 284
sulfurea (Pers.) Quél., 284
Lactarius Fr., 96
torminosus (Schaeff.) Fr., 81
Lactobacillus Beijer., 316
Lagerstroemeria, 97
Lambertella von Höhnel, 200–12
*Lambertella Corni-maris* von Höhnel, a brown-spored parasitic Discomycete, by T. H. Harrison and A. F. El-Helaly, 199
Lambertella Corni-maris von Höhnel, 199–213
Larix decidua, 157, 158
Lasiobolus equinus (Mull.) Karst., 284
Laurus nobilis, 191
Lecanium, 181
hesperidum, 191
viride, 193
Lentinus Fr., 64, 76

Leocarpus fragilis (Dicks.) Rost., 10
Lepiota (Pers.) Fr., 78
Bucknallii B. & Br., 4
procera (Scop.) Fr., 82
Leptomitaceae, 221, 234
Leptomitus lacteus (Roth.) Agardh, 234, 238
Leptonia Fr., 280
asprella Fr., 282
sericella (Fr.) Quél., 282
serrulata (Pers.) Fr., var. laevipes Maire, 282
Leptospermum, 95
Leptosphaeria doliolum (Pers.) Ces. & de Not., 284
L. G. Windt and Heteroecism, by J. Ramsbottom, 128
List of fungi, etc., maintained in the National Collection of Type Cultures, 1934, by R. St John-Brooks and M. Rhodes, 315
List of Members, 347
Lister, G., "Mycetozoa found during the foray of the British Mycological Society at Newcastle, September 18th–21st, 1933", 10
Lolium, 337, 338, 340, 342
italicum, 342
perenne, 94, 337–42
remotum, 337
temulentum, 94, 337–42
Lophiostoma caulium (Fr.) de Not., 284
microstomum Niessl, 284
semiliberum (Desm.) Ces. & de Not., 284
Luminous Agaric (*Pleurotus* sp.) from South Burma, by S. R. Bose, 97
Lygus communis var. novascotiensis, 181
pabulinus, 181
Lystronychus, 173

Macrophoma Berl. & Vogl., 146
Macrosporium Fr., 147
commune Rabenh., 147
parasiticum Thuem., 147
Marasmius Menieri Boud., 280, 281, 282
peronatus (Bolt.) Quél., 158
ramealis (Bull.) Fr., 280, 282
Massaria eburnea Tul., 284
Matthiola, 115
Melampsorella Symphyti Bubák, 281, 283
Melanospora leucotricha Corda, 146
Melolontha fullo, 191
Members, list of, 347
Mesembryanthemum edule, 191
Metarrhizium Giard, 190
album Petch, 189
Anisopliae (Metsch.) Sorok., 189
*brunneum Petch, n.sp., 189
Micropodia dumorum (Desm.) Boud., 284
Mitrula Fr., 281
sclerotipus Boud., 281, 284, 287
Mollisia Fr., 280
atrata (Pers.) Karst., 284
Mollisia benesuada (Tul.) Phill., 284
cinerea (Batsch) Karst., 284
juncina (Pers.) Rehm, 284
melatephra (Lasch) Karst., 284
Monilia Pers., 26, 146, 209–16
aurantiaca (Lév.) Peck & Sacc., 216
aurea Kitagima, non Gmelin, 216
carbonaria Cke., 216
fructigena Pers., 27, 30, 31, 208, 209, 210
Lupuli Mass., 216
Martii Ell. & Sacc., 216
sitophila (Mont.) Sacc., 215, 216, 217, 218, 219
tetrasperma Shear & Dodge, 218, 219, 220
Monilinia Honey, 212
Moniliopsis Aderholdi Ruhl., 205
Mucidula Pat., 77
alphitophylla (B. & Curt.) Pat., 40
Mucor, L., 146, 300
Mucedo L., 136
racemosus Fres., 217
Musca, 180
Mushroom growing in the United States of America, by W. M. Ware, 344
Mutilla, 172
Mycena Fr., 85, 280
acicula (Schaeff.) Fr., 282
corticola (Schum.) Fr., 282
filopes (Bull.) Fr., 282
metata Fr., 282
tintinnabulum Fr., 100
vitilis Fr., 282
Mycetozoa found during the Newcastle foray, by G. Lister, 10
Mycorrhiza, preliminary observations on, by E. H. Ellis, 157
Myriangium Mont. & Berk., 178

National Collection of Type Cultures, A list of fungi, etc., maintained in, 1934, by R. St John-Brooks and M. Rhodes, 315
Naucoria Fr., 39
cerodes Fr., 282
effugiens Quél., 282
escharoides Fr., 280, 282
graminicola (Nees) Fr., 282
Naumovia Dobrozr., 91, 92, 93
*Naumovia abundans* Dobrozr., by J. Ramsbottom, 91
Naumovia abundans Dobrozr., 4, 91, 92, 93
Nectria Fr., 346
cinnabarina (Tode) Fr., 284
coccinea (Pers.) Fr., 284
*Neurospora* in Britain, by J. Ramsbottom and F. L. Stephens, 215
Neurospora Shear & Dodge, 215, 217, 219
sitophila Shear & Dodge, 218, 219, 220
tetrasperma Shear & Dodge, 217, 218
Nigrospora Oryzae (B. & Br.) Petch, 312

Niptera lacustris Fr., 284
pulla (Phill. & Keith) Boud., 284
Notes on *Bacterium Savastanoi*, by M. d'Oliveira, 346
Notes on the occurrence of *Pyrenophora Avenae* Ito, in Scotland, by R. W. G. Dennis, 288

Observations on *Fomes pomaceus* (Pers.) Big. & Guill., infecting plum trees, by E. Fisher, 102
Observations on the occurrence of bacterial plant diseases in the United States, by A. R. Wilson, 345
Occurrence of *Aplanobacter Rathayi* in Britain, by W. J. Dowson, 345
Oidium aurantiacum Lév., 215, 216
aurantium Cke., 217
lactis Fres., 216
Lupuli Matth. & Lott., 216
Olea (olive), 346
d'Oliveira, M., Notes on *Bacterium Savastanoi*, 346
Ombrophila clavus (A. & S.) Cooke, 284
imberbis (Bull.) Boud., 284
verna Boud., 284
Omphalia candida Bres., 280, 281, 282
flavida Maub. & Rang., 94
*Omphalia flavida*, a luminous and gemmiferous leaf-spot fungus, by A. H. R. Buller, 94
Omphalia gibba Pat., 280, 281, 282
gracilis Quél., 282
grisea Fr., 282
integrella (Pers.) Fr., 280, 282
muralis (Sow.) Fr., 282
stellata Fr., 282
Oospora abortifaciens Quek., 146
aurantia (Cke.) Sacc. & Vogl., 217
aurantiaca (Lév.) Herter, 216
Lupuli (Matth. & Lott.) Lindau, 216
obducens Syd., 189
subfasciculata Petch, 193
Ophiobolus herpotrichus (Fr.) Sacc., 284
Ophiocordyceps Petch, 161, 171
acicularis (Rav.) Petch, 194
*Humberti (Robin) Petch, comb.nov., 172
unilateralis (Tul.) Petch, 171, 183
Orbilia leucostigma Fr., 284
xanthostigma Fr., 284
Oudemansiella Speg., 39

Panaeolus campanulatus (L.) Fr., 282
papilionaceus (Bull.) Fr., 282
sphinctrinus Fr., 82, 282
Patellina Speg., 182
*epimyces Petch, n.sp., 182
Paxillus Fr., 39
atrotomentosus (Batsch) Fr., 81
Penicillium Link, 146, 315
Brefeldianum B. O. Dodge, 277
glaucum Link, 18, 277
sitophilum Mont., 215, 216
Peniophora cinerea (Fr.) Cke., 282
detritica Bourd., 282
incarnata (Pers.) Cke., 282
longispora (Pat.) von Höhnel & Litsch., 282
Penomyces Giard, 190, 191
Cantharidum Giard, 192
cladosporiaceus Sacc., 191, 192
telaria Giard, 192
Pentace burmannica, 97
Peronospora alta Fuck., 284
effusa Rabenh., 284
nivea Unger, 284
parasitica (Pers.) Tul., 284
Urticae Casp., 284
Pestalozzia Hartigii Tub., 146
Petch, T., "Isaria", 34
"Notes on entomogenous fungi", 161
Petri dish cultures, some further notes on the preservation of, by S. P. Wiltshire, 259
Peucedanum palustre, 281
Phacidium Calthae Phill., 284
Phaeolimacium P. Henn., 39
Phaeosclerotinia nipponica Hori, 211, 212
Phialea bolaris (Batsch) Quél., 284
Philaenus, 179
spumarius, 179
Pholiota Fr., 39, 78, 82
Pholiota flammans Fr., 4, 81
squarrosa (Müll.) Fr., 81
Phoma Fr. em. Desm., 146
radicis Rayn., 338
Phomopsis Sacc., 146
Phragmidium disciflorum James, 283
Phragmites, 280, 281, 282, 284, 287
Phycomyces nitens Kunze, 284
Phyllachora graminis (Pers.) Fuck., 284
Physalacria Peck, 84
Phytophthora de Bary, 223
*Phytophthora Cactorum*, the germination of the oospores of, by E. M. Blackwell, 157
Phytophthora Cactorum (Leb. & Cohn) Schroet., 157
erythroseptica Pethyb., 31, 32
infestans (Mont.) de Bary, 32
*Phytophthora megasperma* Dreschler in Tasmania, by W. J. Dowson, 89
Phytophthora megasperma Dreschler, 89, 90
Pilacre Petersii B. & Curt., 266
Pilát, A., "*Poria Pearsonii* Pilát sp.n.", 195
Pinus sylvestris, 157, 158, 196
virginiana, 197
Pistillaria Fr., 281
aculeata Pat., 280, 281, 282, 285, 286
aculina (Quél.) Pat., 281, 282, 285
acuminata Fuck., 285
graminicola Bourd. & Galz., 285
micans (Pers.) Fr., 282
mucedinacea Boud., 285

Pistillaria pusilla (Pers.) Fr., 282
Queletii Pat., 285
uncialis (Grev.) Cost. & Duf., 282
Pistillina Quél., 84
hyalina Quél., 281, 282
Patouillardii Quél., 280, 281, 282
Plantago lanceolata, 179
Plasmodiophora Brassicae Wor., 114–25
Pleosphaerulina Pass., 145
hyalospora (Ell. & Everh.) Berl., 146
Pleospora Rabenh., 145, 146, 147
Avenae Rathschl., 290
herbarum (Pers.) Rabenh., 146, 147, 148, 150, 284
Pleurotus Fr., 78, 97, 98, 101
algidus Fr., 78
candescens F. v. M., 97
cyphellaeformis Berk., 78
facifer B. & Curt., 97
Gardneri Berk., 97
igneus Rumph., 97
illuminans F. v. M., 97
japonicus Kaw., 97
Lampas Berk., 97
mastrucatus Fr., 78
nidiformis Berk., 97
noctilucens Lév., 97
olearius DC., 97
palmatus (Bull.) Quél., 78
phosphoreus Berk., 97
Prometheus B. & Curt., 97
Pluteus Fr., 39, 85
admirabilis Peck, 81, 82
cinereus Quél., 286
exiguus Pat., 286
hispidulus Fr., sensu Konr. & Maubl., 282, 286
murinus Bres., 286
nanus Pers., 282
nanus Pers., var. lutescens Fr., 282
plautus Weinm., 286
Polistes americana, 171
Polybia fasciata, 172
Polydesmia pruinosa (B. & Br.) Boud., 284
Polyopeus Horne, 145–52
purpureus Horne, 146, 150
purpureus var. latirostratus Horne, 146
Polyporus (Micheli) Fr., 280
betulinus (Bull.) Fr., 283
gilvus Schw., 103, 104, 107
igniarius Linn., 102, 105, 110
nummularius (Bull.) Quél., 283
picipes Fr., 283
squamosus (Huds.) Fr., 104, 110
subacidus Peck, 197
varius Fr., 283
Polyrrhizium Giard, 190
Leptophyei Giard, 190, 192
Polysaccum crassipes DC., 95
Polystictus versicolor (L.) Fr., 283
xanthopus Fr., 79
Populus tremula, 198
tremuloides, 102, 109
Poria Pers., 195
corticola Fr., 198
hypobrunnea Petch, 335
medulla-panis Fr. (non Pers.), 195, 196, 197
medulla-panis Pers., 197
*Pearsonii Pilát, n.sp., 195–8
subacida Peck, 197, 198
vulgaris Fr., sensu Rea, 283
*Poria Pearsonii* Pilát, sp.n., by A. Pilát, 195
Potts, G., "Experiments on finger-and-toe disease (*Plasmodiophora Brassicae*)", 114
Preliminary account of the parasitism of *Ustulina vulgaris*, by W. H. Wilkins, 95
Presence and absence of an endophytic fungus in *Lolium temulentum* and *L. perenne*, by K. Sampson, 94, 337
Presidential address by W. Brown, "Mechanism of disease resistance in plants", 11
Proceedings, 94, 154, 344
Prunella, 4
vulgaris, 91, 92
Prunus americanus, 102
Psalliota Fr., 78, 81, 82, 83, 345
arvensis (Schaeff.) Fr., 344, 345
campestris (Linn.) Fr., 344, 345
hortensis (Cke.) W. G. Sm., 345
Psathyra Fr., 85, 280
bifrons, B., 283
gossypina (Bull.) Fr., 283
Typhae Kalchbr., 280, 281, 283, 286
Typhae Kalchbr., var. Iridis Boud., 286
Psathyrella Fr., 280
atomata Fr., 283
disseminata (Pers.) Fr., 283
gracilis Fr., 283
Pseudobalsamia microspora Diehl & Lamb., 344
Pseudomicrocera Henningsii Petch, 194
Pseudopeziza Trifolii (Biv.–Bern.) Fuck., 284
Psilocybe bullacea (Bull.) Fr., 283
foenisecii (Pers.) Fr., 283
inquilina (Fr.) Bres., 283
Psychotria, 193
Puccinia Pers., 34, 35, 36, 136, 137
bromina Erikss., 283
bullata Wint., 281, 283
Centaureae DC., 283
Cirsii Lasch, 283
Cnici-oleracei Pers., 283
coronata Corda, 247, 281, 283
Glechomatis DC., 283
glumarum (Schm.) Erikss. & Henn., 138
graminis Pers., 11, 13, 20, 137, 138, 252
Helianthi Schw., 252
Holcina Erikss., 283
Hypochaeridis Oud., 283
Lolii Niels., 283
Magnusiana Körn., 283
Malvacearum Mont., 242, 250
Menthae Pers., 283

Puccinia obtegens Tul., 283
Orchidearum-Phalaridis Kleb., 283
persistens Plowr., 283
Phragmitis Körn., 283
Poarum Niels., 250, 283
pulverulenta Grev., 283
Taraxaci Plowr., 283
triticina Erikss., 138, 247
Pulvinaria mesembryanthemi, 191
Pulvinula Boud., 280
constellatio (Cke.) Boud., 284
Punicum granatum, 139, 140
Pustularia capsularis (Linn.) Fuck., 4
Pyrenopeziza millegrana Boud., 284
Pyrenophora Fr., 288
*Pyrenophora Avenae* Ito, in Scotland, by R. W. G. Dennis, 288
Pyrenophora Avenae Ito, 288, 289, 290
teres Dreschler, 288
Pyronema confluens Tul., 216
Pythiacystis Smith & Smith, 26
Pythiomorpha Peters., 222, 223, 236
gonapodioides Peters., 236, 238
Pythiomorphaceae, 223, 236
Pythium Pringhs., 28
de Baryanum Hesse, 23–32

Ramsbottom, J., "Naumovia abundans Dobrozr.", 91
"L. G. Windt and Heteroecism", 128
"*Fragmenta Bibliographica*", 159
Review: *Die Pilze Mitteleuropas*, Bd. 1. Die Röhrlinge, by F. Kallenbach, 96
Review: *The genus* Diaporthe *Nitschke and its segregates*, by L. E. Wehmeyer, 160
Ramsbottom, J. and Stephens, F. L., "*Neurospora* in Britain", 215
Ranunculus repens, 179
Raphanus, 115
Reseda odorata, 115
Reviews: *Die Pilze Mitteleuropas*. Bd. 1. Die Röhrlinge (F. Kallenbach), by J. Ramsbottom, 96
*The genus* Diaporthe *Nitschke and its segregates* (L. E. Wehmeyer), by J. Ramsbottom, 160
Rhipidium Cornu, 221, 222, 234
americanum Thaxt., 235, 238
continuum Cornu, 234
europaeum von Minden, 221, 234, 235, 238
*europaeum von Minden, var. compactum E. J. Forbes, nov.var., 234, 238
interruptum Cornu, 234
Rhizoctonia Solani Kühn, 89
Rhizopus Ehrenb., 28, 30, 146
nigricans Ehrenb., 18
Rosellinia de Not., 146
Rumex, 180
Russula violacea Quél., 280, 283

Sampson, K., "The presence and absence of an endophytic fungus in *Lolium temulentum* and *L. perenne*", 94, 337
Saprolegnia Nees., 223
bodanica Maurizio, 223
diclina Humph., 226
dioica de Bary, 226
dioica Pringsh., 223, 226
dioica Schr., 226
esorina Maurizio, 223
ferax (Gruith.) Kütz., 223–38
lactea Pringsh., 234
mixta de Bary, 223–8
monoica Pringsh., 225, 226
monoica Pringsh., var. glomerata Tiesenh., 226
semidioica Peters., 225
Thureti de Bary, 223, 224
Saprolegniaceae, 221, 223
Saprolegniales, 221
Sapromyces Fritsch, 221
Reinschii (Schroet.) Fritsch, 221
Scatophaga, 180, 181
Scirpus, 280, 287
Sclerotinia Fuck., 20, 25, 209, 211, 212, 281
aestivalis, 208, 209, 210
Curreyana (Berk.) Karst., 284
Duriaeana (Tul.) Quél., 284
fructicola (Wint.) Rehm, 200, 210
fructigena Ader. & Ruhl., 199, 200, 210
Libertiana (Lib.) Fuck., 23
phaeospora Hori, 211, 212
Rolfsii, 23
Scopulariopsis brevicaule Link, 146
Secale (rye), 128–38
Sempervivum, 240–53
tectorum, 242, 252
Webberi, 242, 248
Senecio, 170
Septobasidium Pat., 37, 194
Sepultaria Cke., 280
arenicola (Lév.) Mass., 284
Sinapis (mustard), 114, 122, 125
Single spore cultures, note on the isolation of, by D. D. Gupta, 154
Sisymbrium, 114, 115
Smith, N. J. G., and Pope, F. B., "The association between the Gasteromycete *Polysaccum* and *Eucalyptus* roots", 95
Solenia anomala (Pers.) Fr., 283
Sonchus, 191
Sphaeria sobolifera Berk., 175
Sphaeropsis malorum Peck, 146
Sphaerotheca pannosa (Wallr.) Lév., 284
Spicaria Harz, 36, 37, 38
(Isaria) farinosa (Dicks.) Petch, 38, 177
Spinacia oleracea, 115
Sporotrichum Link, 186, 187
album Petch, 186, 187
*columnare Petch, n.sp., 186, 187
isarioides Petch, 186
larvatum Peck, 188, 189
larvicolum Peck, 188, 189
roseum Link, 146, 152
Stemphylium Wallr., 147
Berlesii Oud., 147

Stenocorus mordax, 177
Sterculia, 100, 101
*Stereocrea coccophila Petch, n.sp., 178
Stereum (Pers.) Massee, 280
hirsutum (Willd.) Fr., 283
purpureum (Pers.) Fr., 106, 283
Stilbella Lindau, 170
Stilbum (Tode) Juel, 94
St John-Brooks, R. and Rhodes, M., "A list of fungi, etc., maintained in the National Collection of Type Cultures, 1934", 315
Stromatinia Boud., 211
Stropharia Fr., 78, 83
Studies in British Pyrenomycetes. I. The life histories of three species of *Cephalotheca* Fuck.", by C. G. C. Chesters, 261
Stysanus Stemonites Corda, 147
Symphytum officinale, 280, 281, 282

Tapesia evilescens (Karst.) Sacc., 284
fusca (Pers.) Fuck., 284
retincola (Rabenh.) Karst., 284
*Thamnidium elegans* Link, variation in, induced by the action of high temperatures, by B. Barnes, 291
Thamnidium elegans Link, 291–312
Thraustotheca achlyoides Coker & Couch, 232
Torrubia Tul., 175
Humberti (Robin) Tul., 170, 172
Melolonthae Tul., 165, 166
Torrubiella Boud., 162
Trematosphaeria mastoidea (Pers.) Rabenh., 284
Tremella mesenterica (Retz.) Fr., 283
Tricholoma Fr., 39, 74, 78, 82
acerbum (Bull.) Fr., 4
melaleucum (Pers.) Fr., 280, 283
Trichopeziza carinata Cke. & Mass., 284
Grevillei (Berk.) Sacc., 284
Trichothecium roseum Link, 147
Triphragmium Ulmariae Wint., 283
Triticum (wheat), 128–38, 345
Tubaria W. G. Sm., 78, 83
furfuracea (Pers.) W. G. Sm., 81, 283
Tubercularia granulata Pers., 190
vulgaris Tode, 190
Tulasnella violea (Quél.) Bourd. & Galz., 4
Tunstall, A. C., "A new species of *Glomerella* on *Camellia Theae*", 331
Tylenchus tritici, 345
Typhula (Pers.) Fr., 281
candida Fr., 283
erythropus (Bolt.) Fr., 283
Grevillei Fr., 283
gyrans (Batsch) Fr., 283
phacorrhiza (Reichb.) Fr., 281, 283

Ulex, 216, 217
Umbelliferae, 180
Urceolella deparcula (Karst.) Boud., 284
effugiens (Desm.) Boud., 284
leucostoma (Rehm) Boud., 284
scrupulosa (Karst.) Boud., 284
Uredo Pers., 136, 137
Urocystis Anemones (Pers.) Wint., 283
Fabae de Bary, 283
Uromyces Link, 255
appendiculatus (Pers.) Lév., 247
Junci Tul., 283
Polygoni Fuck., 283
Rumicis Wint., 283
Urtica pilulifera, 115
Ustilago longissima (Sow.) Tul., 283
Ustulina vulgaris Tul., 95

Valsa lata (Pers.) Nits., 284
Variation in *Thamnidium elegans* Link, induced by the action of high temperatures, by B. Barnes, 291
Venturia Rumicis (Desm.) Rabenh., 284
Vermicularia Fr., 288
*Verticillium fuliginosum Petch, n.sp., 186
lateritium Berk., 146, 152
Vespa cincta, 170
crinita, 171
Volvaria Fr., 71, 82

Wakefield, E. M., "The Lyndhurst Spring Foray, May 26th–30th, 1933", 1
"The Newcastle Foray, September 18th–23rd, 1933", 4
"Exhibit of fungi from British Guiana", 159
Walnuts, a graft disease of, caused by a species of *Chalaropsis*, by J. B. Hamond, 158
Ware, W. M., "Mushroom growing in the United States of America", 344
Wicken Fen, Cambridgeshire, the fungi of, by E. J. H. Corner, 280
Wilkins, W. H., "Preliminary account of the parasitism of *Ustulina vulgaris*", 95
Wilson, A. R., "Observations on the occurrence of bacterial plant diseases in the United States", 345
Wiltshire, S. P., "Some further notes on the preservation of Petri dish cultures", 259

Xylaria carpophila (Pers.) Fr., 4
vaporaria Berk., 344

Zygorhynchus Vuill., 146

CAMBRIDGE: PRINTED BY WALTER LEWIS, M.A., AT THE UNIVERSITY PRESS